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Imitation Situations: Learning to Use Others as a Resource for Further Activity

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Imitation Situations:
Learning to Use Others as a Resource for Further Activity

by

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To my Moogie, Laurie Papas,

for devoting herself so fully as mother

and for supporting all of my interests throughout my life.

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ABSTRACT

Developmental social-cognition research is dominated by the presumed ubiquity of Folk Psychology (FP). Folk psychology is the assumption that people typically navigate and coordinate their social environment through the ascription of mental states to others. The current paper offers Interactivism (Bickhard, 2011) as alternative perspective on developmental social-cognition in general and on imitation research in particular. Mentalism researchers assume that FP is an essential aspect of imitation activity. In contrast, from the interactivist perspective, imitation activity is understood as a heuristic form of problem-solving in which children are learning how to make use of others as a resource for further functioning. In this general sense, imitation can be characterized as a form of "self-scaffolding" (learning to learn) that is always a product of both the cognitive and motivational aspects of the child that are themselves relative to the broader social situation.

A single study was used to explore three implications of the interactivist perspective. The first implication challenged the adequacy of "active-action" paradigms to explore children's understanding of others' mental states in general and their false-beliefs in particular. The primary conclusion being that they are not diagnostically adequate for demonstrating the presence of false-beliefs in particular nor mental states of any kind in general. The second implication challenged existing interpretations of the recently coined phenomenon of "over-imitation" (imitation of causally irrelevant steps on artifacts). The main conclusion from this study was that children make presumptions of relevance on the basis of previous learning, current motivational processes and always with respect to the broader social context. The third implication tested an empirical

prediction unique to the interactivist perspective. The relevant conclusion from this prediction is that children are not able to explicitly reason about the mental states of self or other until age 3.5-4.

CHAPTER 1: INTRODUCTION – DEFINING IMITATION

The current paper will be framed by two general questions that are central to the investigation of imitation research: First, why do infants and young children imitate (function)? Second, why do infants and young children imitate what they imitate in a given situation (i.e., what individual and situational factors modulate children's selection of what to imitate – expression)? There are two further aspects to this second question: first, what are infants and young children capable of imitating (origins) and why do they show the preferences that they do (motivation)? Finally, to the extent that understanding others' mental intentions has become integral to imitation research, the current paper will explore a non-mentalistic alternative interpretation for how such "mind reading" is accomplished.

Why Do Humans Imitate: Two General Functions – Cognitive and Social

Most broadly, the function of imitation is to learn from others – hence the sense in which imitation is a form of social learning. However, imitation has also been considered as a form of social interaction. The former function has been characterized as the cognitive function of imitation and the latter as the social function. The distinction between these two functions of imitation has been widely recognized but rarely considered the focus of experimental research (Uzgiris, 1981) and only recently has explicit interest resurfaced (Kiraly, 2009; Nielsen, 2006; Nielsen, Simcock & Jenkins, 2008). To be clear, the distinction is not meant to suggest that one of these functions operates to the exclusion of the other, but rather that one of them will tend to dominate the exchange between model and observer while the other remains relatively

unimportant. However, in neglecting the distinction, research has been preferentially focused on the cognitive function and, at times, confounded it with the social function.

Cognitive Function of Imitation.

From the cognitive perspective, imitation concerns learning something new about the world and is used as a means of rapidly acquiring that new knowledge without the need to engage in trial-and-error learning processes. For Uzgiris (1981), Piaget (1962) was the paradigm example of the cognitive view in which imitation was understood as the "accommodatory pole of adaptation. When an individual's assimilatory schemes are insufficient to grasp the model *fully*, imitation is a way of dealing with the puzzlement created by the model" (p. 3, emphasis added; Uzgiris, 1981). The emphasis on "fully" is important because infants' have been shown to demonstrate a preference to imitate the kinds of events that they "understand", but not fully (Killen & Uzgiris, 1981). That is, the type of events that infant's will imitate most readily changes throughout development with a preference for those events that are neither extremely easy for the infant to perform (completely old) nor especially difficult (completely new). The same learning dynamic has been established for research on mastery motivation (Dichter-Blancher, Busch-Rossnagel, & Knauf-Jensen, 1997) and has been described by Kagan (1972; 2002) in reference to infant's preferential exploration of visual displays that are novel but not too novel. Kagan captures the learning dynamic graphically by an inverted-U curve with preference on the Y-axis and degree-of-novelty on the X-axis. In general, the motivational preference for learning that is described by the inverted-U curve is a consequence of the dynamics involved in any sufficiently elaborated, action-based constructivism (more on this later).

Social Function of Imitation.

Infants' will imitate events that are highly familiar and well understood (Kirkham, et al. 2009; Uzgiris, 1981). In these situations, the function of imitation is not to acquire knowledge about the event per se but rather to engage in some form of interpersonal interaction. In the extreme, the content of what is being imitated is irrelevant so long as it enables the type of congruence that can exist between individuals. In these situations the focus is on the realization of a coordination that is present between imitator and model. Kinsbourne's (2005) perspective on imitation is a contemporary example of the extreme social function position: "My argument is that babies love to entrain with adults and that imitation is more about affiliation or attachment than about learning, although it may be about learning too … which is entrainment – adopting shared rhythms of behavior (p. 167)". The analysis by Kinsbourne converges with that of Hobson and Myers (2006) in its emphasis on interpersonal engagement[1] and both perspectives agree that some form of interpersonal engagement constitutes a more fundamental underlying process of which imitation is one manifestation.

Imitation Situations Involve an Interplay between Cognitive and Social Functions.

As noted above, a strict distinction between these two functions serves more of an analytic purpose than a functional individuation of underlying dynamic processes.. Imitation situations usually involve a socially responsive model and so both functions are typically going to be relevant for experimental research. That is, most imitation

[1] Although, for Hobson and Meyers, interpersonal engagement is understood in terms of their notion of *identification* rather than *entrainment*, both of their constructs capture the social affective aspect of interpersonal interactions.

situations are inherently social and so both cognitive and social functions are going to be relevant. Killen and Uzgiris (1981) argue for the differential prominence of these two functions interacting in a single study involving 7.5, 10-, 16-, and 22-month-olds. This study involved three conditions in which infants were able to model simple acts (shaking a doll), socially appropriate acts ("drinking" from a cup) and socially inappropriate acts ("drinking" from a car). The relevant findings were, roughly, that type of act imitated varied with age. The 7.5-month group imitated simple acts most and the others minimally, the 10- and 16-month groups imitated socially appropriate acts more often than either of the other two types of acts and the 22-month group imitated the socially inappropriate acts more often than the younger groups and about equally as often as the socially appropriate acts. These results support the cognitive learning function in that the children imitate those acts that they can understand. However, imitation of simple acts also increased with age, as did socially appropriate acts once they began with the 10-month group. That is, well-understood acts continued to be imitated by the older children. This can be interpreted as a consequence of the social engagement function of imitation in that these already-cognitively-master acts were imitated in order to engage in a shared understanding/meaning of the situation or else to play the "imitation game".

It is also possible to consider the interplay of cognitive and social functions in terms of their corresponding motivational aspects. Kinsbourne (2005) points out that Echopraxia[2] requires arousal to imitate and that it may be during the inherently arousing face-to-face dyadic situations, in which imitation experiments typically takes place, that children are most willing to engage in imitative behavior. But arousal (sufficient for

exploration) can also be understood as deriving from what Uzgiris called cognitive puzzlement (uncertainty). That is, the affective arousal aspect of social interactions may also derive from the inherent properties of cognitive learning processes.

Evidence for this possibility comes from an early study by Harnick (1978) in which he considered the effect of age and task difficulty on fidelity of imitation in a problem-solving situation for infants aged 14-28 months. Consistent with the cognitive view, Harnick found that infants of different ages preferentially imitated the modeled behaviors if the task was of moderate difficulty but not if the task was too difficult or too simple. The latter finding (no imitation if the task was too simple) would seem to indicate that the (interpersonal) social function was not operative. However, all but one of the modeled behaviors was completely irrelevant to accomplish the task (e.g., the behaviors involved banging or waving paired with vocalizations). That is, the cognitive perspective alone would expect infants to ignore the irrelevant action but instead they preferentially imitated them; but only when the problem-solving aspect of the modeled behavior was of moderate difficulty for a given age grouping. A possible interpretation of these results is that the moderately difficult task produced the appropriate amount of "cognitive" arousal and consequently infants were more willing to imitate. More recent research with older children suggests a similar conclusion (Williamson, Meltzoff & Markman, 2008).

In sum, the degree to which an imitation situation is about learning or is about interpersonal engagement then, forms more of a continuum than two unitary points. This

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[2] Echopraxia is the involuntary repetition or imitation of the observed movements of another.

captures the complementary (cognitive and social) functions of imitation while maintaining that "the" function (in any actual situation) is often a matter of emphasis.

Having limned a preliminary answer to the first general question of why humans imitate (to learn about the world and to participate in interpersonal engagements) the discussion now turns to the second general question of why humans imitate what they imitate in a given situation

What Gets Imitated: Two General Aspects – Cognitive and Motivational

Cognitive ability and motivational state are two major *aspects* contributing to children's imitation activity. The cognitive aspect concerns the nature of knowledge representation, learning, and development. This aspect focuses on answering questions concerning what is *cognitively possible* or what is *cognitively preferred/biased* for children engaged in imitation activity. Interest in the motivational aspect has been growing in recent years as researchers re-focus their attention on the *preference* part of the cognitive aspect. Specifically, a new emphasis on the *selection* of what to imitate (Gergely, Bekkering, & Kiraly, 2002; Harris & Want, 2005; Lyons, 2009), in situations where children's cognitive abilities are not in question, has helped to implicitly differentiate motivational from cognitive aspects. The motivational aspect, then, is concerned with answering questions regarding the necessary selectivity that must take place when children engage in imitation activity. However, as with the two functions of imitation (cognitive and social), the cognitive aspect has dominated experimental research.

Cognitive Aspects of Imitation.

Any imitation activity will involve cognitive and motivational *aspects* that are separable from the cognitive and social *functions* of imitation. The cognitive function and cognitive aspect of imitation overlap considerably but they also differ in that the cognitive function is more concerned with *why* children imitate (what purpose does it serve) and the cognitive aspect is focused more on *how* children are *able* to imitate (development and origins). The cognitive aspect is focused on the cognitive requirements involved with the development and origins of imitation. Research in this area has come to concern, not only imitation proper, but also various other forms of social learning (e.g., emulation, mimicry, stimulus/local enhancement). Much of the more recent research on imitation has attempted to tease apart the different forms of social learning for two main purposes. First, to establish which species are and are not capable of "genuine" instances of imitation including trying to determine the *circumstances* under which children are and are not capable of imitation (as well as the other forms of social learning).

The second purpose has had more to do with an implication of the first. Demonstrating "true" instances of imitation has been one way in which social developmental researchers have sought to provide evidence for *mentalism* (the ability to attribute mentality to others for the purpose of understanding their behavior) with a methodology that does not require the use of language. Meltzoff (1995)[3] provides the paradigm example of this technique. In this study, children selected to imitate the intended actions of the adult model (putting a ring on a peg) rather than the literal actions of the adult (miss putting a ring on a peg). On the basis of these results, Meltzoff

[3] This study will be discussed in significantly more detail later.

concluded that children are able to mindread the mental intention of the adult model (i.e., mentalism). Consequently, the separation of different forms of social learning (imitation, emulation, stimulus enhancement, etc.) has provided researchers with a conceptual resource capable of generating alternative interpretations for experimental results from mentalism research.

Nonetheless, differentiating "true" imitation from other forms of social learning does not address the most foundational issue concerning a developmental story about how imitation (of any kind) is possible at all. Heyes and her colleagues highlight the fundamental nature of this question through their discussions (Brass & Heyes, 2005; Heyes, 2001) of the *correspondence problem* (Nehaniv & Dautenhahn, 2002). Most broadly, the correspondence problem concerns how children are able to know (in imitation situations) that there is a *correspondence* between what they themselves are doing themselves and the activity of the model; however, the nature of such a correspondence is deeply related to the issue of what one means by imitation in the first place (more on this below).

Motivational Aspects of Imitation.

There are both historical and conceptual reasons why researchers have not been focused on the motivational aspects of imitation. Much of the post-Piagetian research concerning imitation has taken for granted that infants and children are automatic imitators (Kaplan & Oudeyer, 2007). The purported demonstration that this capacity was innate (Meltzoff & Moore, 1977; 1983) only served to reinforce such a stance because it obscures the possibility that there may be different motivations underlying imitation (hence the limited acknowledgement of the social function of imitation as well). The

lack of consideration regarding different possible types of motivation is further entrenched by the very conceptualization of motivation as some sort of energizing force or drive (in this case, an innate drive). However, motivation can be conceptualized from within two broader theoretical orientations (Bickhard, 2003). The first of these is the one presupposed above: that motivation is an energizing force that is required for an organism to engage in some kind of activity. The second of these takes seriously the fact that living organisms are open systems with endogenous activity that are always doing something. From this perspective, the issue of motivation concerns the organism's selection amongst possible activities. That is, the question is not why does the organism do something rather than nothing (the energizing orientation) but instead why does the organism select this activity over that activity (the selection orientation – Bickhard, 2003). It is in this sense that more recent research has been implicitly addressing the issue of motivation through its concern regarding the selective aspects of imitation activity.

A final reason for researchers' lack of interest in the motivational aspects of imitation derives from their overwhelming focus on the fidelity of the match between model and imitator. That is, rather than consider that different situations might involve different underlying motivations, researchers have focused on interpretations in which the variability (fidelity) of what gets imitated in these different situations is understood in terms of the cognitive *capabilities* of different species (comparative) or the cognitive *preferences* of a given species (developmental). This focus is itself a consequence of the interest in attempting to differentiate forms of social learning (imitation, emulation,

mimicry) in an effort to address different theoretical debates (comparative debates, mentalizing debates, etc.).

In sum, both the cognitive capacities and the motivational states of the infant are relevant for understanding imitation behavior. However, as with the asymmetrical focus on the cognitive function of imitation (over the social function), there has been a strong tendency to emphasize the cognitive aspects as well (over the motivational aspects). Most broadly, the cognitive aspects have been concerned children's ability to imitate throughout development (i.e., scope of application). However, the presumed innateness of imitation in its most rudimentary form has meant that researchers have mostly ignored the correspondence problem (for shadow innate above when introducing the correspondence problem). The presumed innateness (and thus automaticity) of imitation has also contributed to ignoring motivational aspects. Additionally, understanding motivation as an energizing force and the overwhelming focus on the fidelity of the match between model and imitator has obscured the motivational aspects underlying the new emphasis on the selective nature of imitation. Finally, if the cognitive and social functions of imitation were considered points on a continuum, then the cognitive and motivational aspects are better viewed as overlapping circles that become increasingly differentiated (but never fully). Such an image is intended to capture the inherent relationship between underlying cognitive and motivational aspects while also expressing their increasing independence over developmental time.

The Differentiation of Imitation Into Types of Social Learning

Social learning is a broad term that can be applied to situations in which organisms learn from the activity of other conspecifics (usually through observation).

This was essentially the definition of imitation that was adopted in the animal literature in the early part of the last century. For example, Thorndike defined imitation as "learning to do an act from seeing it done" (Thorndike 1989; as cited in Byrne, 1999, p 63). However, the progressive differentiation of this very broad construal of imitation into successively more narrow sets of situations has refined the earlier definition of imitation. Illustratively, Byrne (1999) suggests that the history of animal imitation research has been a succession of reinterpretations of previous findings originally thought to be the result of "true" imitation. As a consequence, in contemporary research, imitation is typically defined very generally and then by elimination of other processes (Zentall, 2006).

Germane Forms of Social Learning.

These other processes that are eliminated before concluding true imitation constitute the variety of different forms of social learning. One of the earliest of these was Spence's notion of *stimulus enhancement* (Spence, 1937; as cited in Byrne, 1999). Stimulus enhancement concerns the salience of an object or location (*local enhancement*) that results from the activity of a conspecific with that object or at that location. *Mimicry* as studied by animal researchers concerns the ability of one species to appear physically like another (Zentall, 2006). However, in developmental research it concerns the replication of a model's action without any deeper knowledge regarding the relevance or even the goal of the model (Tomasello, Kruger, & Ratner, 1993). *Affordance learning* can be understood as learning something about how the world works (Zentall, 2006) independent of how that affordance is revealed (i.e., the wind, another conspecific, etc.). While *emulation learning* also involves learning something about how the world works,

it involves a deeper understanding of the causal relationships between objects or their underlying properties (Tomasello, 1990; Want & Harris, 2002a). A further distinction, that is often conflated, (Heyes & Ray, 2002) is that between mental *goals* and *results* in the world. Recognizing this distinction enables the further differentiation of *emulation* into *goal emulation* and *result emulation*. In both cases the observer learns that a particular outcome is possible without regard for the particular actions or object movements that brought it about (Whiten, 2006). For goal emulation it is assumed to be the model's mental representation of that outcome that is known by the observer, and for result emulation, it is simply a potential outcome in the world that is assumed to be known by the observer. While there are multiple other forms of social learning (Moore, 2004; Whiten, 2006), it is the ones just discussed (stimulus enhancement, mimicry, affordance learning and emulation learning) that are most relevant for human developmental studies.

Defining Imitation.

Despite the variable uses and discussions of the different types of social learning across literatures, there is a general consensus that imitation requires an untrained (novel) *behavioral match* of both method and outcome (if there is one) between imitator and model with the relevant causal connections (how the method relates to the outcome) between the two (Heyes, 2001). However, the general consensus quickly breaks down when one examines the different literatures on imitation. The variety of research questions, concerns and underlying motivations for the different domains and disciplines that study imitation have had important implications for how the phenomenon is understood. For example, much of the animal literature has been more concerned with

adaptive value than with the underlying cognitive process that are responsible for such adaptability (as is the case for developmental psychology). Consequently, there is often confusion, conflation and equivocation both between and within research studies on what is meant by the different forms of social learning. Even comparative researchers often have fundamentally different questions and concerns than do strictly developmental researchers, and, as a consequence, different ideas about relevant research designs and interpretations of experimental results (see Byrne, 2005 for some concrete examples).

Call and Carpenter (2002a,b) have provided a framework for thinking about imitation research that can then be used to generate the different forms of social learning. The basic idea is to decompose types of social learning into the more fundamental elements of *actions*, *results,* and *goals* much like chemical molecules are decomposable into their atomic elements. That is, actions, results, and goals are the constituent elements from which the different forms of social learning can be constructed (e.g., action only = mimicry; result only = result emulation; goal only = goal emulation; action + goal = 'blind' imitation; action + goal + result = 'insightful' imitation). However, Call and Carpenter also construe these elements as the three sources of information available to observers that engage in social learning practices. But for these three variables to be both the constituent elements of social learning mechanisms as well as constituting the available "sources of information" through which social learning mechanisms operate is to define the mechanisms of social learning in terms of what gets copied. But, to define a cognitive mechanism in terms of what gets copied is to commit a broader epistemological error that conflates description with explanation (Campbell & Bickhard, 1986).

Historical Contextualization for Current Research

This particular difficulty of defining a cognitive process in terms of external behavior is not specific to Call and Carpenter's generative base (actions, results, and goals) per se; but rather, is inherent to the general approach towards the study of social learning. The forms of social learning discussed above originated from within the animal learning literature. This literature is commitment to an associationist stimulus-response framework[4] that has influenced how many researchers characterize and investigate such learning. In particular, the general acceptance of the "two-action method"[5] as an attempt to establish those cases of "true imitation" has meant that researchers are often defining imitation in terms of how it is measured. Accordingly, it has been suggested that all researchers using the two-action method are ultimately appealing to an operational definition devoid of cognitive content (Byrne, 1999; Zentall, 2006). However, the situation within developmental psychology is a little bit more complicated.

In general, although developmental psychologists strive to understand the origins, nature, and developmental processes of the underlying cognitive mechanisms that eventuate in behavior, this commitment has had limited success with respect to imitation research (Jones, 2005). While the possible psychological ontologies[6] regarding the

[4] To the extent that these researchers are interested in the adaptive value of *behavior*, they have not been particularly concerned with the potential richness of the cognitive processes underlying that behavior. Consequently, the cognitively austere associationist framework of stimulus response psychology has provided a natural fit for their approach.

[5] The two-action method is an experimental paradigm in which separate groups are exposed to a model performing some task. Each group observes the model apply a different method to accomplish the task and then they are tested on their own. If there is a tendency for the subject to use the method that was modeled, then they are considered to have imitated. In this way, each group serves as an experimental and control condition for the other.

[6] Ontological commitments concern the fundamental nature of *whatever* reality one is talking about. This can include anything from the magical ontology of Harry Potter to the atomistic ontology that once dominated physics. For an associationist framework, the

nature of imitation are often richer for developmentalists than what is available to associationist frameworks (more common in animal research), progress has still been limited. There are multiple factors that have contributed to the limited exploration of the conceptual possibilities for what the cognitive and developmental processes underlying imitation behavior might be. The current discussion will consider three such factors that are represented by three groups of researchers: (a) Meltzoff and colleagues, (b) Tomasello and colleagues, and (c) Want, Harris, and "mentalist" skeptics.

Meltzoff and Colleagues.

Much of the early work by Meltzoff and Moore (1977; 1983; Meltzoff, 1988a) set the research agenda within mainstream developmental psychology and perhaps most influential was their demonstration that neonates were capable of imitation. A general and widespread strategy for developmental researchers during this period was to challenge Piagetian theory by establishing that various cognitive abilities were present far earlier than Piagetian theory could accommodate (Fischer & Bidell, 1991). Towards such ends, the focus was on the presence or absence of the specified cognitive ability for different age groups and not on a developmental account of pre-requisites or pre-cursors. For imitation research, this focus on presence or absence parallels the preoccupation of animal researchers with the question of which species are capable of imitation and which ones are not. Subsequently, the same general structure of the two-action method, used as a litmus test for attributing imitation between species, was now being used as a litmus test within a species (i.e., homo-sapiens).

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fundamental nature (ontology) of mind concerned the learned associations between stimulus and response, while for more contemporary developmentalists the ontology of

Despite methodological and conceptual criticisms of the purported demonstration of neonatal imitation (Anisfeld, 1979; 1991; 1996; 2005; Anisfeld, et al., 2001; Jacobson & Kagan, 1979; Jones, 1996; 2006) the overwhelming consequence of these innateness claims was the general move away from a developmental perspective and, in particular, away from Piagetian theory. That imitation might be innate precludes the possibility that imitation itself might be learned and further, it obscures the possibility that imitation might change in important ways with subsequent development (Tissaw, 2007). If imitation is innate, then there is no fundamental difference between the matching behavior of a neonate and an infant, or between an infant and a two-year-old. As a consequence, research will not be focused on how imitation itself might develop over time but rather on how it manifests in different situations (i.e., what factors are relevant for its expression). Finally, adopting an experimental approach that structurally mirrors the two-action method has tended to enable the lingering vestiges of operational definition to permeate our understanding of how we conceptualize the *meaning* of imitation.

Related to this anti-developmental, operation-defining perspective is the abandonment of the rich theoretical resources provided by Piagetian theory in particular and a lack of energy devoted to theorizing about imitation as a cognitive process more broadly. While Meltzoff has since provided his own theoretical account of imitation (Meltzoff & Moore, 1997) a concern for modeling underlying cognitive processes is the exception rather than the rule. Further, Meltzoff's ultimate concern has been to establish

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mind also includes representations, goals, motivations, constructivist learning and memory processes, etc.

a foundation for his account of *mindreading*[7] abilities. To that end, the innateness of imitation is required in order to justify the origins of his *supramodal*[8] representations precisely because his broader epistemological framework makes such emergence impossible. In sum, much of Meltzoff's work has been concerned with demonstrating the presence of imitation (under different circumstances) in order to draw broader theoretical conclusions about mindreading rather than to investigate the underlying dynamics of imitation as a cognitive phenomenon in its own right.

Tomasello and Colleagues.

Concern for the cognitive mechanisms underlying imitation activity is consistent with the general shift away from the limited psychological ontology of behaviorism (i.e., associations between stimuli and responses). Tomasello (1996) explicitly contrasts his *cognitive* perspective on imitation with that of more traditional associationist approaches. He suggests that, from the cognitive perspective, "organisms reproduce the behavior of others at *different levels* [richness of cognitive processes] and in different ways depending on their *perception* or *understanding* of the behavior to be reproduced" (italics mine, p. 324). The key distinction that separates Tomasello's cognitive perspective on imitation from associationist ones is whether the observer understands (in some cognitively rich sense) something about the mental intentions of the model – how some behavior is relevant to the completion of a mentally represented goal.

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[7] Mindreading is the term popularized by (Nichols and Stich, 2003) to talk about Theory of Mind (TOM) abilities and is being used here in a broad sense to capture Meltzoff's strong inter-subjective stance (the "like me" stance, Meltzoff, 2007).

[8] These representations are "universal" in the sense that they are not specific to any one modality. Consequently, supramodal representations allow for the translation in and out of the different modalities and underlay how infants can assume the "like me" stance (Meltzoff, 2007).

> Imitative learning, my version of the ever elusive "true" imitation, requires that the learner perceive and understand not just the bodily movements that another individual has performed (mimicking), and not just the changes in the environment that that individual's behavior has resulted in (emulation learning). The learner must also understand something of the 'intentional' relations between these, that is, how the behavior is designed to bring about the goal (p. 324).

While Tomasello's cognitivist view means that he is willing to incorporate into his theorizing that the "same" situation can be understood differently by different species (on the basis of what they attend to and represent about that situation), he provides few conceptual resources to help clarify or model what imitation is (as a cognitive process) beyond what was already available to animal learning frameworks. Specifically, instead of only externally visible factors (behavioral activity, environmental outcomes) Tomasello and his colleagues have introduced a perceptually hidden factor: that other people's mental intentions play a role in imitation activity. As two of Tomasello's colleagues cited above suggest (Call and Carpenter, 2002a,b), imitation (as a social learning mechanism) should be conceptualized in terms of three constituent elements: actions, results, and goals; rather than just two: actions and results. One of the methodological consequences then, is that researchers started looking at "matching" behavior with respect to other people's intentions (Carpenter, Akhtar, & Tomasello, 1998; Meltzoff, 1998) in addition to other people's actions or environmental results.

Similar to Meltzoff, Tomasello is primarily interested in imitation as a theoretical resource for understanding social cognition more broadly rather than as a cognitive process in and of itself; however, unlike Meltzoff, Tomasello is less concerned with

justifying an innate foundation for the representational requirements adequate to mindreading (Meltzoff's strong inter-subjectivity). Rather, Tomasello appeals to an innate foundation regarding the motivation to share psychological states with others (weak inter-subjectivity - Tomasello, Carpenter, Call, Behne, & Moll, 2005). This motivational foundation is then supplemented with a developmental account of the representational requirements for shared intentionality that itself is the basis for cultural transmission and imitation is understood as one manifestation of such shared intentionality. Ultimately, Tomasello's concern is to explain how a small evolutionary difference (between us and other primates) could enable the possibility of culture and thus cultural evolution (Tomasello, 1999). Consequently, understanding and sharing mental intentions (as manifest by imitation) is essential for his account of "cultural cognition" (Tomasello, et al., 2005).

Want, Harris and Mentalist Skeptics.

Want and Harris (2002) argue that developmental psychology could benefit from the recent "revolution" in comparative psychology. Specifically, doubts about the prevalence of imitation in the animal kingdom lead researchers to develop a more highly differentiated taxonomy of types of social learning (several of these were discussed above) than what had tended to be used by developmentalists (see Whiten, 2006). Part of the reason for this was the difference in focus between the two groups. Comparative psychologists were typically looking at how objects were manipulated or tools were used while developmentalist were often more interested in facial and manual gestures or simple actions on objects (Want & Harris, 2002a). Because certain forms of social learning (e.g., emulation) can only be differentiated experimentally if the task involves

the manipulation of objects, developmental methodology was often precluding certain potentially relevant alternative interpretations a priori.

Utilizing the more highly differentiated taxonomy from comparative psychology, a number of researchers have re-interpreted some of the imitation results previously taken in developmental psychology as demonstrating the ability to attribute mental goals and intentions (Gergely, et al., 2002; Heyes, 2005; Huang, Heyes & Charman, 2006; Thompson & Russell, 2004). However, the skepticism about what type of social learning (imitation versus emulation or stimulus enhancement) was operative in these original experiments has as much to do with imitation per se as it does with social cognition more broadly. That is, much of the skeptical research is opposed to the general position that infants and toddlers are inferring the mental states of adults (mentalism) in these experimental situations. It was mentioned above that both Meltzoff and Tomasello were making use of imitation as an evidential base for their broader theoretical concerns regarding social cognition (weak and strong inter-subjectivity) and so arguments against the presence of imitation are often de facto arguments against mentalism.

However, the current relevance of discussing Want, Harris, and mentalism skeptics is simply to highlight that importing the more differentiated taxonomy of types of social learning from comparative psychology does not directly address substantive issues regarding the nature, origins or development of imitation as a cognitive process. As has been argued with respect to infant research more broadly (Allen & Bickhard, *in press*; Mueller & Giesbrecht, 2008), focusing exclusively on methodological considerations will not be sufficient to resolve the conceptual differences. The lack of energy dedicated to exploring *explanatory* frameworks is evident in the comments of

other researchers that, in general, there is yet to be an adequate theory of imitation (Byrne, 2005; Jones, 2005; 2007). With their abandonment of Piaget's account of early imitation (Piaget, 1962), so too did developmentalists undermine the effort to explain imitation as (a) cognitive process(es).

In sum, much of the research on imitation in developmental psychology has been as much about establishing (or ruling out) rudimentary forms of mentalizing as it has been about imitation per se. The general concern with mentalism and the presumed innateness of both the *ability* to imitate and the *motivation* to imitate has in turn resulted in a lack of concern regarding the origins, development, and dynamics of imitation as a cognitive process. In practice, imitation is often used as a dependent measure that tends to be divorced from other cognitive processes (Barr, 2002). Finally, the taxonomy imported from comparative psychology may provide greater clarity in the classification of imitative (and non-imitative) behavior, but it is not equivalent to an explanation of imitation in such situations.

CHAPTER 2: THEORETICAL DISCUSSION OF THE LITERATURE

Organizing the Literature

The human capacity for imitation is considered to be one of the central means by which human culture is preserved and elaborated by successive generations. Of course the extent and complexity of human culture is so radically different from any other species that imitation (as one of the primary mechanisms of that radical difference) provides interesting opportunities for comparative analysis. Accordingly, there are extensive literatures on imitation for both human and non-human populations; however, the current paper will focus primarily on the development of imitation in human children.

The developmental literature on social learning will be organized according to three interrelated aspects: complexity, mentalism, and imitation as a phenomenon. With respect to what gets demonstrated by the model, Want and Harris (2002) suggest that research on social learning can be divided into three categories of increasing complexity: first are bodily movements, these include both facial and manual gestures (e.g., tongue protrusions, hand-waving); second are simple actions on objects, these include a single action on a familiar (or highly affordant object – e.g., pushing a button or shaking a rattle); finally, complex actions on objects will often include multiple steps in a sequence and may involve learning how to use tools (e.g., learning how to unlock a box with a key). Matching this progressive increase in modeled complexity is a concomitant elaboration in the potential types of social learning that can be experimentally differentiated. For example, standard tongue protrusions are both the ends and the means and so the differentiation between actions and results/goals is not even possible. Further, that there are no objects involved with tongue protrusions eliminates the possibility of

considering the two forms of enhancement (stimulus and local). Even with simple actions, there is often only a single means (or highly constrained means) to the presumed ends and so replication of both actions and results does not necessarily indicate imitation. For example, turning on a light switch with your hand is unlikely to differentiate between emulation (turning on the light) and imitation (turning on the light with your hand) because of the overwhelming tendency to use your hand for such tasks. Often, it is only with the complex manipulation of objects (something found with tool use) that there can be meaningful discussions about whether participants are engaged in imitation or emulation learning.

With respect to mentalism and imitation as a phenomenon, a distinction can be made between those studies that are more concerned with establishing (or refuting) the hypothesis that infants and toddlers have access to the mental states of others and those studies that are more interested in imitation as a phenomenon in its own right. Importantly, the two sides of this distinction are a matter of emphasis given that many of the respective studies will inherently be addressing both. That is, researchers who use imitation as a methodology to investigate whether infants and toddlers have the ability to attribute mental states to other people (e.g., mental goals and intentions) are simultaneously providing evidence for the potentially relevant role that those mental states might play in imitation situations (e.g., that toddlers copy the intentional activity of other people, Carpenter, et al., 1998; Meltzoff, 1995). It is also the case that researchers who are interested in imitation per se may investigate how the mental states of the model might influence what gets imitated and in so doing be providing indirect evidence that imitators are sensitive to the mental states of other people (Lyons, Young, & Keil, 2007;

Williamson & Markman, 2006). Finally, the investigation of imitation as a phenomenon will help to elaborate on the general cognitive perspective advocated by developmental psychology and promoted by mentalist researchers.

Outline of the Theoretical Discussion of the Literature

Because the issue of complexity cuts across both of the other two aspects (mentalism and imitation per se), it will not be addressed independently; rather, it will be discussed in the specific contexts where it is relevant. Nevertheless, the literature review will still have three sections. Section one will consider the mentalism aspect with respect to how imitation has been used as a research paradigm for broader theoretical considerations concerning social and cultural cognition. This will involve the original break from Piaget that was largely initiated by Melzoff and Moore (1977; 1983) with a focus on the more recent criticisms of those who accept and promote mentalist interpretations of the research.

Section two will consider those researchers who have redirected their attention to the study of imitation as a phenomenon with its own inherent complexities and developmental dynamics. This will involve research that has explicitly explored the alternative social function of imitation (Killen & Uzgiris, 1981; Kiraly, 2009; Nielsen, 2006; Nielsen, et al., 2008; Uzgiris, 1981) as well as those who have focused on the social function to better understand what is being learned in the various imitation situations (Gergely, et al., 2002; Kiraly, Jovanovic, Prinz, Ascherslenben, & Gergely, 2003). This latter research has redirected attention to the *selectivity* of imitation that contrasts strongly with the presence of *over-imitation* (imitating causally irrelevant actions on objects). The focus on selective- and over-imitation opens the door to explore

some of the underlying cognitive and developmental dynamics involved in imitation activities (Lyons, 2009).

Section three will draw on the previous two sections to motivate the current research project. This will involve an analysis of those research designs that have attempted to provide evidence of mentalism as well as explicitly considering motivation, and presumptions of relevance, as variables of central importance in the exploration of imitation activity. This latter exploration will require looking at the different types of experimental situation in which imitation has been explored (communicative, pedagogical, play, etc.). Finally, I will suggest that an anticipatory model of representation can facilitate that exploration.

Section 1: Social Cognition and Mentalism

Piaget on Imitation.

According to Piaget's (1962) analysis, the onset of *representational* imitation coincides with the beginning of object permanence in stage IV (8-12 months) of the sensorimotor period. At this point, the ability to imitate *novel* sounds and gestures emerges along with active experimentation of new models of all kinds in stage V (12-18 months). Jed - For example, … It is not until stage VI (18-24 months) that the infant is claimed to be able to engage in: "immediate imitation of complex new models, *deferred* imitation and imitation of material objects resulting in representation. Hitherto, the child has only been able to imitate immediately movements and sounds already known to him, or those which could be reproduced merely through co-ordination of earlier simple schemas" (italics mine, p. 66). Subsequently, Meltzoff and Moore have provided a series of experiment to establish the presence of (invisible/opaque or representational) imitation

in neonates (Meltzoff & Moore, 1977; 1983; 1989), deferred imitation in 9-month-olds (Meltzoff, 1988b) and deferred imitation of a completely novel act in 14-month-olds (Meltzoff, 1988a) as part of their effort to provide an alternative account to that of Piagetian theory.

The Argument from Precocity

Despite early criticisms of Meltzoff and Moore's (1977) original challenge to Piaget's account (Anisfeld, 1979; Jacobson & Kagan, 1979), they were able to established an experimental paradigm (Meltzoff & Moore, 1983) for research that was then used to systematically and rigorously dismantle the account that had been attributed to Piaget[9]. Their general strategy was consistent with the more global attempt by developmental psychologists to empirically demonstrate that certain abilities were present earlier than purportedly required by Piagetian theory (Brain, 1959; Bryant & Trabasso, 1974; Gelman, 1969). However, the more specific attempts to establish that some of these abilities were present very early in infancy (so early that they were likely to be innate) constituted more of a direct challenge to both the explanatory and descriptive adequacy of Piagetian theory (Baillargeon, 1987; Baillargeon, Spelke, & Wassermann, 1985; Spelke, 1985). The "argument from precocity" (Fischer & Bidell, 1991) entails not just that Piagetian theory requires adjustment in terms of its descriptive time line, but rather that the underlying developmental account of that time line must also be incorrect. That is, researchers applying the argument-from-precocity-strategy tended to conclude that Piagetian theory had been refuted leaving a theoretically barren nativism in its place.

[9] See Anisfeld 1991; 1996; 2001; 2005 for a thorough review of all the research on neonatal and deferred imitation and his ultimate conclusion (2005) that there is "no

While there have been a number of more recent criticisms of these purported refutations of Piaget's account, the focus of these criticisms has been on the nativist conclusions (Bogartz, Shinskey, & Schilling, 2000; Haith, 1998; Schoner & Thelen, 2006) rather than the possible implications with respect to Piagetian theory (Allen, 2009). Further, the relevant issues (for both critics and proponents of nativist positions) are typically thought only to concern methodology (Kagan, 2008). However, it has been argued that differences in underlying epistemological frameworks must also be addressed in order to reconcile and transcend the problematic elements of nativist research in general (Allen & Bickhard, in-press; Mueller & Giesbrecht, 2008).

Despite coinciding with this developmental nativist movement that emerged in the late 70's and early 80's, Meltzoff and Moore's program of research has both convergences and divergences with that movement. While Meltzoff and Moore's implementation of the general precocity argument exemplified developmental nativism par excellence, their subsequent account was substantially more developmental[10] than that of most other nativist proposals (Meltzoff & Moore, 1997). Further, while the nativist research program was built around interpretations of Piagetian theory that mostly ignored important details and relevant distinctions, Meltzoff and Moore were more thorough in their analysis[11]. That said, both groups failed to fully appreciate the broader

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compelling evidence to dispute Piaget's timetable of the development of representational imitation in infancy".

[10] With respect to social cognition Meltzoff and colleagues distinguish themselves from stronger nativist positions by using the label "starting-state nativism": the basic idea is that the innate starting state is "leaner" than that of other nativist positions and that it develops in fundamentally important ways (Gopnik & Meltzoff, 1993).

[11] With respect to object permanence, Meltzoff and Moore (1998) criticize developmental nativists precisely for failing to observe some of the salient distinctions present in Piagetian theory.

epistemological framework from within which Piaget was operating (Chapman, 1988; Lourenco & Machado, 1996) and this has had a lasting impact on how infant research has been investigated (Allen & Bickhard, *in press*). Specifically, the focus of both groups on the methodological issues involved in demonstrating the *presence* of the ability of interest has obscured Piaget's emergent constructivist action perspective. The lasting impact for imitation research has been an overwhelming lack of effort to consider imitation as a developmental phenomenon.

However, one of the developmental aspects of imitation that Meltzoff and colleagues have attempted to address is the correspondence problem. The correspondence problem concerns: how an imitator "knows" what is required for their own movements to match that of a model[12] (Brass & Heyes, 2005). The correspondence problem is particularly acute for situations involving invisible (opaque) imitation because the imitator cannot use vision as a basis for the match. This is part of the reason why Meltzoff and Moore were focused on neonatal facial imitation. However, like most appeals to innateness, their solution to the problem is not a solution but rather constitutes a justification for positing a theoretical primitive in their framework (Samuels, 2002; Simpson, 2005). Specifically, the supramodal representational system is a theoretical primitive posited to provide the "cross-modal metric of equivalence" that solves the correspondence problem and enables the infant's "apprehension that the other is, in some primitive sense, 'like me'" (Meltzoff & Moore, 1997, p. 185).

Having established that neonates have functional access to knowledge of a fundamental equivalence between self and other, Meltzoff and colleagues have pursued

the theoretical integration of that "empirical" fact with their mindreading account of social cognition more broadly (Meltzoff, 1995; 2007a,b; Meltzoff & Brooks, 2008; Meltzoff & Gopnik, 1993). A major experimental nexus for such integration concerns Meltzoff's (1995) re-enactment (imitation) paradigm that was used to establish that 18-month old children were capable of understanding the intentions of others. However, any discussion of experimental research that uses imitation to explore children's developing ability for mentalism must be situated in the broader context concerning the development of social cognition.

Navigating Our Social Environment.

Folk Psychology (FP) is presumed to be the method by which the average person navigates and understands his/her social interactions. Unlike the physical world, the social world involves interacting with intentional agents whose behaviors are (assumed to be) caused by a variety of mental states (e.g., beliefs, desires, intentions, goals, hopes, wishes, preferences, etc.). Theory of Mind (TOM) research can be understood as the study of FP's development and application. That is, developing the ability to successfully interact with intentional agents through the ascription of mental states (beliefs/desires/intentions/goals about the world) is at the core of TOM research. The general assumption endorsed by TOM researchers, then, is that social interaction is typically realized in terms of the ability to explain or predict the behavior of others on the basis of their beliefs, desires, intentions, goals, and other mental states.

For theoretical, methodological, and historical reasons, the developmental focus for TOM research started at around age four (Wimmer & Perner, 1983) and has shifted

[12] For a broader notion of the correspondence problem see Nehaniv and Dautenhahn

over time to progressively earlier ages (Bartsch & Wellman, 1989; Hala & Carpendale, 1997; Lillard & Flavell, 1990; Onishi & Baillargeon, 2005). With roughly a 10-year lag on this TOM research, studies concerning the possible foundations for social learning (imitation, emulation, etc.) has progressively moved forward (developmentally) from some of the earliest work on goals at around six months (Gergely, Zoltan, Csibra, & Szilvia, 1995). The currently relevant consequence of this research dynamic is that potentially problematic, taken-for-granted assumptions regarding the original TOM framework have been buried even deeper below the surface of debates that are now concerned with whether the foundations of social cognition involve mentalizing or not[13] (for a similar point see Gergely, Egyed, & Kiraly, 2007, p. 140). That is, many of the debates within developmental psychology concerning social learning mechanisms must consider that researchers promoting a mentalist interpretation are constrained and motivated by their prior commitment to (or even just their acceptance of) aspects of the original TOM framework[14]. The strong claim would be that mentalist interpretations of some "imitation" research requires the TOM framework for their warrant and rationalization. The potential problem is that, to the extent that research on social learning is tied to the TOM framework, problems for the later are also problems for the former. There is a very real sense then in which much of the imitation literature is intrinsically bound by prior and ongoing TOM research.

(2002).

[13]The failure to differentiate between goal as an *end-state in the world* and goal as a *mental representation of that end-state* (Heyes & Ray, 2002; Want & Harris, 2002b) is symptomatic of just how deeply buried certain assumption have become.

[14] Meltzoff (1995) states explicitly that, "being a representationalist [TOM] entails being a mentalist" (p. 838).

Ratcliffe and colleagues. What if most of our social cognitive abilities do not primarily involve folk psychology and therefore TOM? What if the application of FP is a highly specialized, late developing ability that is only used in moments of reflection and not for the coordination of the overwhelming majority of our social interactions? A number of researchers have recently challenged the assumption (that is typically not even mentioned, let alone argued for) that commonsense FP is in fact common (Hutto & Ratcliffe, 2007). These researchers all differ in the extent to which they accept FP as actually being involved in social engagements with the most austere recognition coming from Ratcliffe. Ratcliffe (2007) challenges whether the taken-for-granted assumption that "*everyday interpersonal understanding, construed as the attribution of the intentional states in order to predict and explain behavior"* (p. 224) is in fact the case. Virtually all TOM debates have been concerned with arguments about *how* this assumption is actually implemented and what the developmental time course of that implementation looks like.

Ratcliffe points out that investigations of FP have not derived from a careful descriptive analysis of various social situations in an effort to determine where FP is operative; but rather have started with philosophical assumptions that imply FP and then attempted to investigate its development and application to social life. Part of the allure for this approach is that any situation can, in fact, be rendered in FP terms (i.e., there is always a belief-desire pairing that can "explain" some behavior) but that does not mean that FP is actually involved[15]. Ratcliffe makes the point succinctly: "What I am looking

[15] That the possibility of such an FP rendering does not imply its reality is a particular example of the general tendency for over-representationalism. One of the points highlighted by the dynamical-systems-theory opposition to representationalism (Port &

for here is an argument that arrives at FP through a study of social life, rather than an argument that arrives at FP through a debatable set of philosophical presuppositions and then proceeds to impose it on social life" (p. 241).

Ratcliffe goes on to challenge the assumed pervasive ubiquity of FP as well. His investigation begins with the recognition that social interactions are heterogeneous and take place within social contexts. There are many situations in which shared knowledge about the normative context are sufficient for the coordination of interacting agents. These include situations in which there are too many other agents to plausibly suppose that mental ascriptions drive the interaction (e.g., riding the subway[16]). Even situations with only two individuals are often negotiated without any recourse to mental states (e.g., two cars approaching each other, using a cross walk, getting the bus driver to pick you up). In these types of situations, conventional norms do the work of coordinating our social interactions. The powerful role that shared knowledge about norms plays in coordinating our interactions can be extended both to social roles (e.g., if the phone rings in the office it is the secretary who will answer) and artifact functions (a saw is for cutting) where the normative aspect is completely independent of any particular person and certainly need not appeal to his/her mentality at all.

One of Ratcliffe's main conclusions is "that FP has no psychological reality and is instead an abstract philosophical systematization of social life, the utility of which is unclear" (p. 224). Regardless of the validity of this radical conclusion, Ratcliffe has

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van Gelder, 1995) was that such a framework could always construe the behavior of a system in representational terms even though such a construal had no reality regarding the actual interactions of the system (e.g., the Watt Governor).

[16] While our familiarity with norms regarding public transit may obscure their presence, consider how different transit norms were 50 years ago.

surely provided sufficient plausibility to the claim that FP (as the ubiquitous ascription of intentional states for the purpose of interacting with other people) cannot simply be assumed without justification. That is, the supposed ubiquity and obviousness of FP can no longer be a taken-for-granted assumption. The implications of this challenge against FP for discussions concerning social learning in general and imitation in particular are that: (1) research regarding social learning is constrained and motivated by the assumed ubiquity of FP; (2) there is growing recognition that many social situations do not (and in some cases, could not) involve the application of FP; and, (3) alternative proposals concerning these (non-mentalistic) social situations provide alternative conceptual resources for understanding imitation research.

What are Your Intentions: Meltzoff, 1995.

Meltzoff's (1995) experimental procedure provides one of the major methodological and conceptual resources for the claim that 18-month-old infants can understand and attribute goals and intentions to the behavior of others (mentalism)[17]. This study introduced the "behavioral re-enactment paradigm" designed to build on infants' "natural" proclivity to copy the behavior of adults. Specifically, 18-month-old infants were shown a model manipulating some objects and then given a turn with the objects themselves. In the *failed-attempt* condition, the manipulation did not fulfill the *intention* of the model to bring about some target acts on objects (e.g., seeming to attempt to put a loop over a peg, but missing). The experimental question was whether infants would copy the model on the basis of the physical displacement of the objects ("in purely physical terms") or on the basis of the goal that the model intended to perform ("the

underlying goal or intention to act"). In the *full-demonstration* condition, the model succeeded in his or her attempt to bring about the target acts on the objects (e.g., put the loop over the peg). Results indicated that infants were equally likely to complete the target acts in both conditions. Meltzoff concluded that these infants were able to infer the intention of the model and decided to "imitate" on the basis of this inference. Importantly, there were two additional control conditions. A *baseline* condition was used to determine how frequently infants would perform the target acts without any demonstration and a *adult-manipulation* condition was used to control for target act being preformed as a consequence of the model drawing attention to the objects (stimulus enhancement).

The empirical response to intention reading. Nevertheless, there have been some more recent alternative interpretations of the original results that included additional control conditions. Huang, Heyes and Charman (2002) have considered the potential role that emulation learning and stimulus enhancement may have played in the original study. In an *emulation* condition, infants were shown the initial state of the objects, a barrier was erected to occlude the model while they acted on the object and then removed to reveal the end-state of the objects. While Meltzoff's original study used an adult-manipulation condition to control for stimulus enhancement, Huang et al. suggest that it was insufficient because it differed from both the full-demonstration and failed-attempts conditions in terms of the spatial contiguity of the target-relevant parts of the objects (i.e., it controlled for attention directed at irrelevant parts of the objects). Huang et al.'s *spatial contiguity* condition had three relevant aspects: first, the model

[17] See Bellagamba and Tomasello (1999) for a replication of these results with 18-, but

acted on the target-relevant parts of the objects; second, these parts were moved within close proximity of each other; and finally, each demonstration was presented only once.

The overall conclusions from Huang et al. were that emulation learning and stimulus enhancement enabled infants to produce an equivalent number of target actions to the full demonstration and the failed-attempt scenario. Of further interest was the finding that the full-demonstration condition differed significantly from the other three when measuring if the first action the infants took was a target action. The authors suggest that the first action taken is equally as important to consider as whether the target action is eventually enacted (at some point during the test phase) because it may help to differentiate between imitative and non-imitative social learning strategies. Finally, the authors highlight the relevance of prior knowledge about dynamic object affordances. They point out that infants imitated few of the target-irrelevant actions in their replication of Meltzoff's adult-manipulation condition. Nor did they imitate what was demonstrated in the spatial contiguity condition, preferring instead to complete the afforded (target) action of the objects (e.g., placing the ring on the peg rather than holding it out in front). The point then is that infants of this age, with their prior knowledge about objects, may be reluctant to imitate irrelevant actions when they are pitted against a demonstration of the dynamic object affordances that are relevant for completing the target act[18].

Interestingly, when the above conditions were explored with 2.5- and 3.5-year-old children they demonstrated the same pattern of target-act performances as the younger groups; however, they were also willing (or able) to imitate the control acts in the adult-

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not 12-month-olds.

[18] For an empirical demonstration of this possibility see Brugger, Lariviere, Mumme & Bushnell, 2007.

manipulation condition and the 3.5-years-olds alone imitated the specific actions demonstrated in the failed-attempt condition rather than the "intended" outcome (Huang, et al., 2006). This latter finding suggests that it is not until 3.5 years of age that children are willing (or able) to subvert production of the actions afforded by simple dynamic object demonstrations (target/"intended" acts) with what is actually demonstrated by the model ("failed-attempt" acts). Finally, Huang and Charman (2005) explored how different forms of emulation learning (object movements) in 17-month-olds may be able to account for the failed-attempt findings from Meltzoff's original (1995) study. They used a modified video demonstration in which the model was edited out of the film and only the movements of the objects were visible. Whether infants saw the initial state, transformational process, and end-state (object movement reenactment), just the first two (dynamic affordance learning – "failed attempt") or a full demonstration (all three with the model not edited out) made no difference for the number of target acts produced[19].

Summary. Two major conclusions can be drawn from the work by Huang and colleagues: First, dynamic object affordances provide a viable alternative to the intentional interpretation of the failed-attempt condition in Meltzoff's original study. At a minimum, these findings provide empirical support against any claim that an intentional interpretation is *necessary* to account for the *failed-attempt* condition. A stronger conclusion is that these findings provide empirical support for the position that there is no functional role served by an inference about intentions in the *failed-attempt* conditions. Second, the consistent finding that infants and toddlers in the full demonstration

[19] As with Huang et al., 2002, 2006, the full demonstration always differed from the other groups in terms of the number of target acts produced as the first action, while the other two group showed similar patterns.

conditions had significantly greater productions of target acts as their first act performed is theoretically important. The differential exploration of the objects during the imitation period suggests that infants and toddlers may have had different learning experiences and likely used different cognitive strategies across conditions (full-demonstration versus failed-attempt, emulation, and spatial contiguity).

Conceptual Issues Concerning Intentions and Goals.

Huang and colleagues present what might be considered methodological concerns in that they systematically explored some plausible alternative control conditions. In so doing, they have raised some serious doubts about the conclusions of Meltzoff's original (1995) study. However, there are also some conceptual issues that need to be addressed – in particular, the underlying logic and presuppositions required for the *rich* mentalistic interpretation of the data in the first place. Meltzoff (1995) appeals to a distinction made by Searle (1983) regarding two broad types of intentions, namely *prior intentions* and *intentions in action*. Prior intentions are "those mental states that occur in the mind of the actor in advance of the action being preformed … These are to be distinguished from *intentions in action*, which are what is involved at the moment of purposely performing a particular bodily movement (vs. when it happens accidentally or reflexively)" (p. 847). When Meltzoff and others are talking about intentions, they are typically using it in the latter purposeful (non-accidental but fully psychological) sense of the word.

However, Meltzoff acknowledges that his failed-attempt condition does not actually differentiate whether infants understood the behavior of the model as deriving from a failure of their unobservable intention or a failure of their unobservable goal: "Children in these studies may have imputed such states [intentions in action], or they

may have stopped short and simply interpreted the goals of the actions" (p. 848). As a limitation of this particular study this is certainly not a substantive criticism, but there is a larger problem in the field: researchers often equivocate the notion of an intention (in action) with the idea of a goal (as mental state).

There are several, progressively more important implications regarding the conflation between intentions and goals. First, research that is experimentally testing hypothesis about goals can be interpreted as providing support for discussions that are concerned with intentions (Carpenter, 2006; Woodward, Sommerville, & Guajardo, 2001). This problem is potentially exacerbated by the additional conflation (mentioned previously) between goal-as-mental-state and goal-as-outcome-in-the-world (Heyes, 2002; Tomasello, et al., 2005; Want and Harris, 2002b). From these two conflations (intention/goal and goal/outcome) follow conclusions about intentions that derive from research involving outcomes. That is, experimental evidence concerning the development of infant knowledge about outcomes in the world may be taken as evidence for research that is concerned with establishing the presence of infant knowledge about the intentions in the minds of others (Carpenter, Call, & Tomasello, 2002; Heineman-Pieper & Woodward, 2003; Kiraly, et al., 2003b).

Second, the conflation between intentions and goals promotes ignoring alternative attempts to understand "goal"-direct behavior in non-mentalistic terms. That is, the conflation obscures research findings that have provided a non-mentalistic interpretation of infant's sensitivity to goal-direct behavior (Gergely & Csibra, 2003). Further, evidence that infant's *do not* respond to mechanical devices as goal-directed/intentional (Meltzoff, 1995) is used to support a mentalistic interpretation (because these devices do

not *actually* have minds); however, research demonstrating that infant's *do* respond to the behavior of mechanical (non-mentalistic) devices as goal-directed/intentional (Press, Gillmeister & Heyes, 2007; Johnson, Booth, & O'Hearn, 2001) is explained away by appeal to the idea that infants are over-generalizing[20] to these devices on the basis of *relevant* surface cues (Meltzoff, 2007). That is, both evidence that demonstrates and evidence that fails to demonstrate that infants' respond to mechanical devices as goal-directed/intentional is interpreted as supporting a mentalistic framework.

Such reasoning makes the experimental evidence theoretically meaningless with respect to a mentalistic stance. However, this way of thinking betrays a deeper conceptual issue that derives from an implicit presupposition regarding the nature of perception. Mentalist positions are committed to an epistemological framework in which knowledge is represented in terms of a correspondence between the *representation* in the head and the *object* in the world. For perceptually unavailable aspects of the world (e.g., the mind of another person) there is no *input* from the world that could serve as the basis for the formation of a correspondence. The classic alternative to the world as the source of knowledge is the inherent nature of the mind itself. While Meltzoff and colleagues' specific developmental account regarding the *origins* of one's knowledge about mental states (Gopnik, 1993; Meltzoff & Gopnik, 1993) is fraught with conceptual difficulties (see BBS commentaries on Gopnik, 1993), there is a very literal sense in which the mind of the infant is itself the source for perceptually unavailable knowledge about mental states. As a consequence, mentalist researchers who are committed to a correspondence epistemology are equally committed to a model of perception in which there is a

[20] See also, Schwier, van Maanen, Carpenter and Tomasello (2006) for the same

fundamental split between the surface behavior present in the *movement* of all objects (what is available to perception) and the deeper psychological level present in the *actions* of agents (what must be inferred through the prior knowledge of the mind).

In a review of his original re-enactment study, Meltzoff (2007) discusses the logic of the *failed-attempt* condition: "To an adult, it was easy to read the actor's intentions although he did not fulfill them. The experimental question was whether infants also [like adults] read through the literal body movements to the underlying goal of the act" (p. 32). In the 1995 study, Meltzoff explicitly disregarded the distinction between intentions (in action) and goals because the major issue that he was trying to establish in the original study (understanding others in terms of unobservable psychological states – mentalism) was about mentalism in general. That is, Meltzoff was most concerned with establishing the general claim that infants had "begun to distinguish the surface behavior of people (what they actually do) from another deeper level. [because] This differentiation lies at the core of our commonsense psychology" (p. 848). It is here that we see a specific example of the fundamental epistemological assumption intrinsic to the broader mentalist research program – the idea that there is a fundamental split between the (perceptually available) surface structure and the (unobservable) deep structure.

Surface behavior is presumed to be constituted by the physical displacements of an object and model, while inferences about the deeper psychological level provide access to the *meaning* of that modeled behavior. The theoretical relevance of using imitation procedures for the broader mentalism debate, then, is to demonstrate that the match between infant and model *requires* access to more than just the surface behavior –

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reasoning with respect to "rational imitation" involving a toy dog.

to understand the (perceptually hidden) meaning of the agent's actions requires that the infant go beyond what they can know from perception alone. It is in this sense that the logic of imitation procedures are structurally similar to Chomsky's Poverty of the Stimulus Argument (POS).

Surface Structure and Deep Structure.

Chomsky (1959) famously argued that the language input available from the environment was not sufficient to account for the actual language capacities that ultimately develop in humans. Consequently, there must be some other source of knowledge from which these capacities derive and for Chomsky this alternative source was the genome. That is, Chomsky concluded that the mind was innately endowed with the requisite knowledge necessary to account for subsequent language acquisition. While Meltzoff and his colleagues attempt to provide a post-natal developmental account of how the nature of mind acts as the source of the additional knowledge necessary to uncover the meaning of a model's actions, the logic of their procedures is fundamentally committed to a similar foundational split between surface structure and deep structure.

Consider that mentalist researchers often motivate our intuitions about the fundamental split between surface structure and deep structure with examples that demonstrate both how the same physical movements of the body can have different meanings depending on the intentions of the agent producing them, and also, how different physical movements can have the same meaning for that agent (Carpenter, 2006). However, the further conclusion that an inference about underlying mental states is required to provide meaning/intentionality to behavior is a non sequitur. That is,

despite the fact that actions can be meaningful in all sorts of ways, what constitutes that differential meaning is an open question.

Now reconsider Meltzoff's (1995) study – infants in the *failed-attempt* condition *did not* imitate on the basis of the model's "true" intentions at all. The model's true intention was to *miss* the peg. If knowledge of the experimenter's intention was driving the infants decision about what to imitate, then they failed to correctly *read* that intention. But, Meltzoff reported that adults who viewed the actions of the model were able to "correctly" identify what the actor was trying to do (e.g., put the ring on the peg). It is only within the experimental context that we understand that the true intention was to miss the peg. By analogy, consider that the genius of watching a showman pretend to fumble about is that we perceive the activity as accidental despite knowing that it is a practiced performance. In a good performance, the intentionality that we perceive "directly" and the "actual" intentionality that requires incorporating the theatrical context will differ. A major claim of the current analysis is that the confusion that we are encountering derives from the mistaken idea of a "true intention". This idea is itself indicative of a much deeper philosophical problem concerning the nature of meaning: the assumption that meaning is ultimately determined by reference to some sort of mental structure.

Mechanistic Theory of Meaning.

Goldberg (1991) has a general argument[21] against the idea that meaning, in a social situation, is constituted by knowledge about the mental states of other people. The

[21] The argument is presented as a generalization of Fodor's argument (derived from Wittgenstein) against Bruner on why the very idea of thoughts as images is incoherent. However, as Ulrich Muller has suggested (personal communication) the argument is

argument is initially applied to Fodor (1975) and his view of language and thought but is also extended to Chomsky (1965) and his grounding of the meaning of sentences in the deep structure of the mind: "Sentences acquire meaning because they are associated with, by being 'transformations' of, internal structures. It is the internal structure which has intrinsic meaning" (Goldberg, 1991, p. 57). Appealing to the deep structure explains how the same utterance can have different meanings (i.e., they have different, intrinsically meaningful, internal structures) and how different utterances can have the same meaning (i.e., they have the same, intrinsically meaningful, internal structure).

Goldberg's point is that the use of internal structure to ground the context dependence of meaning only pushes the problem deeper below the surface without actually accounting for it. That is, Goldberg agrees with Chomsky and Fodor in their pointing out that the idea of an unambiguous (intrinsically meaningful – context independent) sentence is conceptually incoherent given the obvious role of context; but disagrees with them in their attempt to disambiguate those sentences by appeal to some mental structure (i.e., no structure has intrinsic meaning – neither sentences nor mental states).

Goldberg argues that the alternative is to recognize that meaning is not just a relational property of sentences (as do Fodor and Chomsky), but that meaning is a relational property of the social situation in general. Just as the humor of sentence is going to be relative to the situation so does the meaning of a sentence apply as it does because of the ongoing flow of human activity. Given that the idea of an unambiguous, intrinsically meaningful, context independent structure is conceptually incoherent, the

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probably best understood as overcoming the erroneous narrowing of Fodor's rendering of

most that one can establish is that a meaningful situation will be understood in one way rather than some other. Goldberg points out that this is not to replace an Internal Structure Theory of Meaning with a Contextual Theory of Meaning but rather to suggest that the very idea of a theory of meaning, in which there is a "final analysis" of the meaning of a sentence, is itself ill conceived. The meaning of a sentence is no different in kind than its other properties (e.g., sentences can be powerful, witty, friendly, ironic) and any explanation about why it has one of these properties is going to depend on the interests of the questioner (i.e., the idea of a final analysis is not possible).

The criticism of assuming that the meaning of sentences derives from the internal structure of the speaker applies equally to the assumption that the meaning of action is constituted by the mental intentions of the actor. Action is certainly intentional, but that property is not known through access/inference/attribution to some mental state inside the head of the actor. As with sentences, the intentionality of action is no different in kind than its other properties (beauty, grace, precision, elegance) and any judgments about these properties is going to depend on a number of factors: the context of the situation, prior knowledge of the judge, past performance of the actor. Further, our perception of the intentionality of action need not appeal to mentalism at all (Marken, 2002; Powers, 1973). That is, the possibility of differentiating intentional from accidental action does not require the capacity to attribute mental states to another person. There are alternative proposals for how we are able to perceive intentional action that do not involve mentalism. In sum, the intentionality of action *cannot* be understood as derivative from

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Wittgenstein's argument.

knowledge structures with intrinsic meaning that are divorced from the current situation and ongoing flow of human activity.

Intentional and Accidental Actions.

Tomasello and his colleagues have taken the lead on exploring how situations involving accidents, trying (failed-attempts/inability), willingness, and prior knowledge can further elaborate our understanding of the nature of the infants' knowledge about intentionality (Behne, Carpenter, Call, & Tomasello, 2005; Carpenter, 2006; Carpenter, Akhtar, & Tomasello, 1998; Carpenter, Call, & Tomasello, 2002; Tomasello, et al. 2005). The tasks used in these studies have a logical structure that is similar to that of false-belief tasks: "Indeed, studies of accidental and unfulfilled intentions are analogous to studies of false belief, as they involve deviations from the true state of affairs, and thus may be considered an 'acid test' of understanding others' intentions" (p. 317). However, this comparison is false in some crucial respects.

The power of standard false-belief tasks comes from the need to draw a conclusion on the basis of reasoning about how the world is *falsely* represented by another agent in contrast to how the world is *actually* represented by the experiencing subject. Both the generation of (and reasoning within) a counterfactual space, and the coordination of that space with the actually represented world make standard false-belief tasks particularly diagnostic for claims about mindreading abilities: beliefs are "representational states par excellence", they possess truth-value. However, beliefs are "quarantined" from bodily actions in a way that is not true for desires, emotions, intentions, goals, etc. That is, they do not share with the latter group of mental states the close coupling to bodily actions: "When someone sees *x* or desires *y*, there are telltale

bodily movements that correlate with such mental states" (Meltzoff, 2007, p. 29) – no such correlations exist for belief states. Meltzoff's original (1995) study on failed-attempts acknowledges and builds off of the distinction between mentalism (that others have mental states directing behavior) and representationalism (that some of those mental states involve interpretations about how the world is – they involve truth value). From this distinction follows an asymmetry: "One can be a mentalist without having a representational model of the mind, but being a representationalist entails being a mentalist" (p. 838). The relevance of this asymmetry for the comparison between false-belief tasks and accidents/failed-attempt tasks is that false-belief tasks are (presumably) not *possible* without explicitly reasoning about perceptually unavailable counterfactual states of affair, while the latter (accidents/failed-attempts tasks) typically involve "telltale" bodily signs. That is, while false belief tasks may, in general, be diagnostic of reasoning that involves attributing perceptually hidden (false) belief states to the agent, tasks involving accidents/failed-attempts will typically be interpretable in terms of alternative non-mentalist accounts. For this reason, extant tasks involving accidents/failed-attempts are not any more diagnostic than those involving intentional/successful-attempts.

To reiterate, what the mentalist researcher wants is a situation where the mental intention/goal diverges from what actually takes place in the world (precisely what one gets with false-beliefs). However, the basis for determining beliefs is importantly different from that of intentions. Beliefs are true or false, while intentions succeed or fail (goals obtain or fail to obtain). Accordingly, we do not attribute a false-intention to someone like we attribute beliefs that end up being false; rather, we evaluate whether

some action was accidental/failed with respect to what should have happened (with respect to the intended act). But if accidental/fail-attempt experiments are only demonstrating that children are sensitive to intentional action (i.e., have expectations about what should happen in a situation) then they are no better than other mentalist paradigm that do not deal with accidents/failed-attempts.

In other words, the primary motivation for moving to accidental/failed-attempt tasks was the universal recognition that a crucial limitation of intentional/successful-attempt tasks was that the interpretations *presupposed* that children had access to others' mental states when that was precisely what they were purportedly testing. Therefore, using accidental/failed-attempt tasks that continue to require assumptions about intentional/successful-attempts continues to beg the question against non-mentalist alternative interpretations.

While, in practice, accidental/failed-attempt tasks may succumb to the same fundamental limitations of intentional/successful-attempt tasks that they were intended to overcome, the diagnostic appeal of the former types of tasks is that they do enable the conceptual possibility of requiring reasoning about perceptually hidden counterfactual mental states in a way that is similar to standard false-belief tasks. The failure of extant research is that it does not recognize the crucial importance of the "quarantined" aspect[22] inherent in false-belief situations. A truly diagnostic case that uses accidental action would be one in which all of the telltale signs indicate that the action is intentional but the

[22] Although the focus here is on the "physical" component of the quarantine, there is also "temporal" component. Beliefs have an influence through time which is why we can get the divergence between a false-belief (established in the past) and the actual state of affairs (established in the present). Intentions (in-action) are established concurrently through unfolding activity in the present.

outcome is "actually" an accident. For example, a soccer player pulls several moves on his opponent, shoots the ball, and scores. Only during the post game interview is it revealed that the goal was an accident because the player's "true" intention was to pass the ball to a streaking forward. In this type of situation there is a clear division between the perceptually available action of scoring a goal and the perceptually hidden mentality of the player intending to pass. While this example does not indicate an experimental task per se, it does illustrate the type of situation that is required to make good on the diagnostic promise of accidental/failed-attempt research.

In sum, the underlying logic of accidental/failed-attempt research enables the conceptual possibility of an "acid test" for mentalism. However, the failure to fully appreciate relevant differences between the nature of beliefs/desires and intentions/goals has meant that extant uses of that logic did not move mentalist research beyond the inherent limitations of intentional/successful-attempt paradigms. Deciding between mentalist and non-mentalist interpretations necessarily involves arguing for (or against) the underlying assumptions and presuppositions that motivate and justify the corresponding interpretations. If mentalist interpretations of experimental research already require assuming that understanding intentional action *must* involve knowledge about underlying mental states, then that experimental research is significantly less powerful than previously thought and the legitimacy of the assumption must be argued on conceptual grounds. The next section considers 3 alternative perspectives on understanding intentional action without the need to mentalize.

Intentionality without Mentalism.

Control theory. The possibility of perceiving behavior as intentional without the need to postulate any sort of inference about (or attribution to) mentality has been explored by a number of researchers. The most austere of these proposals comes from Marken (1982) who has experimentally analyzed intentional and accidental behavior from a control theory perspective (Powers, 1973). He agrees with those who argue that intentionality is crucial for defining behavior/action (as distinct from other physical displacements of the body – i.e., "accidents") and even that it is necessary in order to understand what an organism is doing, but differs from mentalists in terms of how such intentionality is constituted. That is, despite the apparent involvement of mindreading in judgments about intentional behavior, Marken provides a non-mentalist rendering of intentionality (in general) from an alternative control theoretic perspective.

Borrowing from the work of Powers (1973), Marken defines an intended outcome as one that is *controlled*. In turn, controlled outcomes are outcomes that continue to match an internal reference in spite of relevant *disturbances* (perturbations) over time. Subsequently, "to determine if some result is controlled (intended), it is necessary to see whether disturbances of the result produce the expected changes (expected on physical grounds) in the result. If disturbances produce negligible changes…, then the result is probably under control" (p. 648). Thus, the above rendering provides an objective measure to determine if some activity is intentional. Specifically, the lack of a correlation (i.e., ~ 0.0) between changes in the movement under scrutiny and the expected changes of that movement given a disturbance indicates control.

String parsing. In contrast to Marken's attempt to render intentional behavior in terms of control theory, Byrne's (1999) string parsing proposal can be understood as a

more focused attempt to give a non-mentalistic account of imitation. In particular, Byrne proposes to account for the ability of infants to *copy* novel complex behavior without the need to understand anything about the model's mental intentions. His proposal appears to parallel work on language development from a connectionist perspective. That is, if connectionist researchers can be understood as having demonstrated that the linguistic input to the child is richer than Chomsky's POS arguments had assumed, then Byrne can be understood as arguing for something similar with respect to the POS logic implemented by Meltzoff for imitation.

Specifically, for recurring patterns of behavior, a "statistical sketch" can be used to capture the "*underlying* hierarchical structure" of behavior (Byrne, 1999). Assuming that an agent is able to observe some behavior as composed of a sequence of simpler elements, then over repetitions of slightly different sequences, the cross-correlated elements will reveal an underlying organization that will include the starting conditions, the outcomes and the statistical regularities that connect the two[23]. In the case of random strings of elements (i.e., accidents) no statistical sketch would emerge; thus, Byrne states that the "organization of complex [intentional] behavior can in principle therefore be 'perceived' in a rather literal way" (p. 65).

Byrne goes on to suggests that his string parsing model could provide a possible alternative to Meltzoff's (1995) intentional interpretation of the failed attempt condition because "the complete sequence might already have been acquired by string parsing" (p. 71). Regardless of the merits of Byrne's specific suggestion or the adequacy of his model as a whole, he contributes to our current analysis regarding intentions in that he provides

a potential counterexample to the presupposed logic underlying Meltzoff's (and many others') mentalist interpretation. Providing counterexamples to taken-for-granted assumptions is the second way in which Bryne's project parallels the work of connectionist language researchers. For example, connectionist researchers have demonstrated that double dissociations in performance *could* derive from a single underlying network (Munakata, 2001) and that regular and irregular morphology *can* exist in a single system (Rumelhart & McClelland, 1986). Therefore, the possibility that we can perceive the intentionality of behavior directly (i.e., unmediated by inference) becomes a plausible alternative that must be taken into consideration when designing and interpreting experimental data.

Equifinal variation. Gergely and his colleagues have been central to the new generation of research on imitation. Their theoretically grounded research program has contributed to a renewed exploration of imitation activity in a way that is comparable to Meltzoff and Moore's early work with neonates. However, the discussion of their work in this sub-section will be restricted to their relevance for understanding the possibility of perceiving intentional/goal-directed behavior directly, without recourse to inferences about, or mental attributions to, the "agent" of that behavior. Gergely and colleagues have explicitly contrasted their "teleological stance" with positions that endorse various forms of mentalism (Csibra & Gergely, 1998; Gergly, 2002, 2003; Kiraly, et al., 2003a; Kiraly, et al., 2003b).

More specifically, their position argues for a developmental trajectory that delays the capacity for mentalism until somewhere between 14- and 18-months of age (Gergely,

[23] For evidence of action parsing in infants using habituation procedures see Baldwin &

2002; 2003). As a consequence, they have provided a non-mentalist alternative account of the "social cognitive revolution" that seems to take place around 9-months (Tomasello, 1999). That is, these researchers propose an intervening stage between 9 and 14-18 months when infants can only understand self and others as teleological agents.

The teleological stance is a representational system that infants use to understand and interpret the intentional actions of others. The teleological stance differs from the intentional stance in that action interpretation (and prediction) are "reality-based" (Gergely & Csibra, 2007). That is, a principle of rationality[24] is applied to the corresponding *contents* of an agent's beliefs, desires, and intentions such that teleological representations consist of situational constraints, an outcome, and actions to realize that outcome. These contents are all perceptually available aspects of the real world that do not require the superfluous attribution of their mentalistic counter-parts (i.e., beliefs, desires/goals, & intentions).

The availability of teleological representations means that the ability of children to interpret the actions of others as goal-direct needs only to appeal to two types of perceptual cues without invoking the mentality of the agent at all. The basic idea is that infants at this age understand and interpret the intentional actions of others in terms of end-states visible in the world. These end states are represented by the infant and so constitute goal representations but they are not then attributed to the minds of others, they are part of the infant's teleological representation. It is in this sense that the teleological stance is contrary to mentalism because it "applies an externalist, non-mentalistic concept

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Baird, 2001; Baldwin, Baird, Saylor & Clark, 2001.

[24] The principle of rationality is itself grounded in the idea of efficiency and so it too does not require a mentalist rendering.

of 'goal' defined as a future state of physical reality that the action brings about" (p. 774). Therefore, the teleological stance provides a framework for understanding how a *subset* of intentional actions can be represented without reference to the mentality of others. Specifically, the foundation for perceptions/inferences about goal-directedness is the 'principle of rational action'. This principle represents two basic assumptions about the nature of action: first, that the *function* of action is to *change* some particular aspects of the world; and second, that such changes will proceed in the most *efficient (rational)* way possible given the *constraints of the situation*. From these two assumptions follow two types of perceptual cues: a visible action effect and equifinal variation of action. These two perceptual cues form the basis for how the teleological stance accounts for the interpretation of entities as goal-directed. The first cue, a visible action effect, requires that there be some sort of salient change in the world (this relates to the function of action). The second cue, equifinal variation of action, requires that the agent must be capable of employing alternative means to some end as necessitated by the changing constraints of the situation (this relates to the efficiency/rationality of action).

Summary (of last three subsections). At a minimum, not all behavior that is perceived to be intentional requires the further assumption that the perceiver is attributing mental states to the agent of that behavior. The assumption that it does derives from a "poverty of the imagination". Only by assuming a fundamental split between the meaningless world of physical movement and the meaningful world of intentional action, coupled with the further assumption that the meaning of an action is perceptually hidden in the mental states of the actor, does the demonstration of infant sensitivity to intentional behavior *necessitate* the attribution of mental states to the actor by the infant. However,

the first assumption involves a false metaphysics (Bickhard, 2009a; Merleau-Ponty, 1962) while the second commits to a mechanistic theory of meaning which is itself incoherent (Goldberg, 1991).

The three subsections above (Marken, Byrne, & Gergely) provide a progressive elaboration on what it might mean to perceive intentional behavior without attributing mentality to the actor of that behavior. Marken's use of control theory provides a concise sense in which intentional behavior could be detected without recourse to the internal workings of the system under scrutiny. Further, he demonstrates the relevance of the detecting system's own knowledge about the contingencies in the world for setting up the criterial expectations. Byrne explains how his string parsing account of imitation enables the infant to directly perceive the "hidden" structure of behavior through the cross-correlations present in repeated exposure to certain patterns of action. He explicitly claims that his string parsing account provides a possible alternative to Meltzoff's account (1995) that does not require attributing mental states to others. More broadly, his work parallels the connectionist work on language by demonstrating that taken-for-granted assumptions about what "must" be the case, must instead, be defended against alternatives. Finally, Gergely and colleagues go one step further by providing a detailed account of a representational system that provides an intermediary between the richness of mentalism and the austerity of brute physicality. Their investigation demonstrates the power of trying to model some of the cognitive dynamics captured by the infant's own prior knowledge about regularities in the world. That is, certain patterns of activity in the world can be captured in terms of goals (end-states) and teleological representations provide an alternative to the rich mentalist construal of these goals in terms of mental

states. In sum, there is a very real sense in which the perception of intentional action can be rich, complex, and meaningful without recourse to any sort of mentalism.

Piaget's Action-Based Approach.

Failing to adequately explore alternative non-mentalist frameworks for understanding infant perception of intentional action is, in part, a consequence of the taken-for-granted assumption that the world is split between the meaningless movement of objects and the meaningful behavior of intentional agents. This assumption is one of the historical consequences of the original break with Piagetian theory. Piaget's action-based approach was precisely the type of conceptual framework that could have grounded the richness of infant activity without the need for mentalism. In an action-based framework, representation is a matter of engagement. Objects are understood in terms of possible interactions (e.g., a bottle can be sucked on, rolled, thrown). With permanence comes an understanding that these possible interactions remain invariant under many other possible transformations. There is never any inclination in this framework to assume that meaning has to be added to our perceptions of the world. Meaning is constituted in the activity itself and this applies to agents as much as it applies to objects.

Section 2: Contemporary Imitation Research

Rational Imitation as a Productive Resource for Future Research.

The teleological stance has provided a foundation for research that has challenged numerous types of studies involving goal-directness and intentionality in particular and mentalism more broadly (Gergely & Csibra, 2003; Kiraly, et al. 2003). However, it is the seminal paper on rational imitation by Gergely, et al. (2002) that has received the most attention. This study elaborated on an earlier experimental condition by Meltzoff (1988a)

used to demonstrate that 14-month-old infants could engage in *deferred* imitation of *novel* acts. In addition to replicating the original findings, in which infants imitated a model who used their head (with hands placed on the table) to push down on a "light-box", Gergely and colleagues presented a condition in which the model was using their hands to wrap themselves in a blanket (*hands-occupied* condition). The author's *teleological* explanation was that infant's would take into consideration the situational constraint of being wrapped in a blanket when evaluating the rationality/efficiency of the modeled action. In the *hands-occupied* condition the model rationally/efficiently used their head as an alternative *means* to their *end* of turning on the light-box. By contrast, in the *hands-free* condition the model "irrationally/inefficiently" used their head instead of their hands. The results from the new condition demonstrated that infants' were more likely to imitate the head action in the irrational/inefficient *hands-free* versus rational/efficient *hands-occupied* condition.

Despite being explicitly contrasted with the identification perspectives of Meltzoff and Tomasello (Gergely, 2003), these results are typically interpreted in the literature as evidence for mentalism (Tomasello et al. 2005; Schwier, van Maanen, Carpenter, & Tomasello, 2006; Carpenter, 2006; Lyons, 2009). However, for Gergely and colleagues, the results are interpreted as providing evidence that infants actively incorporated their own knowledge about situational constraints into their interpretation of the event and used that understanding as the basis for selecting what to imitate[25]. For

[25] Paralleling the mentalist's interpretation of goal-directedness for mechanical devices, mentalists have used the presence of rational imitation with toy animals (Schwier, et al., 2006) as evidence for the infant's flexibility in "understanding others' intentions as rational choices" (i.e., that infants can generalize to non-agents the property of rational choice). However from the teleological perspective, the finding that rational imitation

contemporary research it is the selective aspect (and thus the infant's prior knowledge) of this study that has harnessed much of the subsequent interest for imitation researchers. Further, with the background influence of TOM waning (and thus issues concerning mentalism declining) research has begun to reexamine imitation as a cognitive phenomenon with its own important dynamics. Part of this resurgence has involved reconsidering the alternative social function of imitation using new experimental methods as well as bringing greater nuance to our understanding of the learning function (through debates involving emulation).

Contemporary researchers all share in the general idea that young children will imitate on the basis of their *understanding* of the situation but differ dramatically in terms of how much attention they give to modeling the nature of that understanding. While the mentalist research that has been reviewed above limits that understanding to accessing the goals and intentions of the model, other programs of research have provided greater elaboration. In addition to *selective-imitation*, the presence of *over-imitation* (imitating the unnecessary steps of a modeled sequence) in other contexts has further complemented the resurgent focus on the possible underlying cognitive dynamics involved in understanding imitation situations (Lyons, 2009) as well as a greater appreciation for the role that might be played by task complexity and prior knowledge (Want & Harris, 2002a).

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has been extended to things without minds provides additional evidence that understanding action as "rational" does not involve any sort of attribution about mental states. Further, rational imitation has been demonstrated for dogs (Range, Viranyi, & Huber, 2007) and some types of non-human primates (Buttelmann, Carpenter, Call, & Tomasello, 2007; Wood, Glynn, Phillips, & Hauser, 2007) which also speaks against a mentalist interpretation (unless dogs too understand other dogs as intentional agents that make rational choices).

Mentalist researchers have acknowledged that intentional/successful-attempt tasks do not provide the diagnostic power needed to differentiate between mentalist and non-mentalist interpretations of imitation behavior because the mental intention will necessarily co-occur with the perceptually available actions of the model and/or the transformations in the world. However, it has been argued in the current paper that their use of accidental/failed-attempt tasks is also diagnostically insufficient. In contrast, part of the power of the original rational imitation procedure (Gergely, et al., 2002) is that it highlights the relevance of the infant's knowledge about how the world works for interpreting the situation independent of any mentalizing. Consequently, even the mentalist has to incorporate the essential role that the infant's knowledge about what is typically done with hands, buttons, and heads into their modeling of the infant's understanding of that situation. That is, the rational imitation procedure casts doubt on the assumption that infants' "understanding rests crucially on – indeed is constituted by – their understanding of that person's intention" (Carpenter, et al., 2002; p. 1431). While the relevance of these other factors does not refute the mentalist overlay, it does (at a minimum) require that these other factors be taken seriously by mentalist researchers in their experimental designs. While explicit consideration of these other factors has tended to manifest most clearly in terms of the debates between emulation and imitation alternatives, the implications are much broader. Specifically, our understanding of imitation can no longer avoid addressing what sort of underlying cognitive and motivational dynamics must be present in order to account for the "imitation" behavior that is manifest in the variety of different experimental situations and contexts in which it has been studied.

Theoretical Unification of Selective- and Over-Imitation.

Lyons' (2009) recent proposal explicitly highlights the need to take imitation's "complex cognitive reality" more seriously. Lyons attempts a theoretical unification of imitation research that reconciles the seeming contrast between *selective*- and *over-imitation*. Lyons highlights a characterization of selective imitation as the active interpretation of situations in which infant's may draw on their prior knowledge about the workings of the world (as well as drawing on the mental intentions of the model). In contrast, over-imitation is characterized by those imitation situations that involve novel artifacts/tools in which the toddler *slavishly* repeats a sequence of steps (some of which are causally irrelevant) to some end (Flynn & Horner, 2007; Lyons, et al., 2007; McGuigan, Whiten, Flynn, & Horner, 2007). Even when the causal irrelevance of these steps is made clear enough for apes to dismiss them, toddlers will continue to copy those irrelevant actions (Horner & Whiten, 2005; Nagell, Olguin, &Tomasello, 1993; Whiten, Custance, Gomez, Teixidor, & Bard, 1996).

Lyons argues that the contrast between selective- and over-imitation can be understood by appealing to the "cognitive" processes of emulation, imitation, and some mechanism for switching between the two. Lyons is explicit in his endorsement of a video-tape model of perception that creates a hierarchy of behavior that breaks action (throwing a ball) down into its sub-goals (pick up ball, wind up, accelerate ball forward, release ball) until reaching some foundational level of "atomic" goals (the contracting and relaxing of certain muscles). Lyons suggests that, for "true" imitation, the imitator copies actions as far down the hierarchy as possible while selective imitation involves switching to emulation part way down and ignoring all sub-goals below a given point.

With respect to learning, the crucial aspect for this proposal is the determination of when the switch is *appropriate*. That is, how can as little fidelity as possible be maintained without losing *relevant* information about what is suppose to be learned. Over-imitation occurs in the domain of tool use where the toddler is claimed to be innately biased not to switch from imitation to emulation because determinations of relevancy (what Lyons calls informational significance) are particularly opaque and thus the learner would be too prone to error if they switched to emulation.

Lyons states clearly that this "computation" about relevance is context specific: "the selective imitator uses cues derived from the larger social and physical context of the modeled behavior in order to judge how faithfully that behavior should be copied" (p. 88). The idea is that the imitator can use *both* the physical constraints of the situation as well as the mental intentions of the model as two major sources of information for determining relevancy and thus when to switch from imitation to emulation. However, for the domain of tool use (in general) the purpose of the situation in which the tool is being used may not be revealed until well into the future. To compensate for the general difficulty that arises from the opacity of tool use, evolution has selected for a bias against emulation and as a consequence imitators are open to the possibility of over-imitation.

I agree with the general value of Lyons' effort to integrate some of the diverse findings from imitation research as well as his desire to take seriously the cognitive complexity that underlies observational learning; however, his integration ignores the developmental perspective. Consequently, he leaves out a number of other potentially relevant findings and ignores the possibility that over-imitation is itself a consequence of learning and development. Further, while providing some clarity on the "cognitive"

processes that he invokes, Lyons does not move beyond the cognitive resources already available to the field. Lyons defines imitation and emulation in terms of the degree of fidelity between model and subject. This is a strictly behavioral definition and as such is inherently at odds with his attempt to more thoroughly address the underlying cognitive processes involved in observational learning. Further, researchers have been at pains to elaborate on the theoretical meaning of these terms beyond their original operational definitions. The use of emulation control conditions to argue against mentalist interpretations is a direct outgrowth of that theoretical progress.

Equally problematic is the selective use of specific experiments as well as the seemingly conflicting uses of the same research. Regarding the latter, Lyons appeals to the experiment by Gergely et al. (2002) as an example of both selective- (*hands-occupied* condition) and over-imitation (*hand-free* condition[26]). Further, over-imitation is supposed to be a consequence of dealing with the opacity inherent in tool use. That is, relevance (informational significance) cannot be determined for tool use and therefore selective-imitation (emulation) is not possible. But this requires that the light-box is understood as both inside and outside the domain of tools/artifacts all within the same experiment. That is, either the box is a tool/artifact and we have a demonstration of selective-imitation (emulation) or it is not a tool in which case we have an example of over-imitation on something that is not in the domain of tools.

More problematic is Lyons anti-developmental approach. Despite the paucity of evidence for research that compares different age groups on the same task (Huang &

[26] However, researchers define over-imitation as copying unnecessary/irrelevant step(s) in a sequence and the hands-free condition really only involves using a less than optimal part of the body to complete a *necessary* step.

Jiang, 2006), when this has been done, the result is one in which selective-imitation (emulation) is replaced by precise imitation. This has been demonstrated by Huang et al. (2006) using Meltzoff's (1995) re-enactment procedure as well as by Gergely (2003) using Gergely et al.'s (2002) rational imitation task[27]. The same developmental trend is also found for the few studies that include multiple age groups (Jones, 2007; Killen & Uzgiris, 1981; Nielsen, 2006). Further, Lyons' contrasts his characterization of the *hands-free* condition from Gergely et al. (2002) with a task in which a mouse is seen to hop/slide across a table to a particular house on the other side (Carpenter, et al., 2005). Unlike using the modeled *means* in the *hands-free* condition, infants in this task only copied the *goal* of putting the mouse in the house, ignoring the means by which it was done. Lyons' suggest that the difference in what was imitated (i.e., means and end for hands-free but just end for mouse sliding/hopping) is a consequence of one condition being more like a play situation and the other being more like a tool use situation. However, additional results make this interpretation difficult to maintain. Other studies have found both selective- and over-imitation in a play situation. First, Schwier et al. (2006) devised a play version of the rational-imitation procedure that produced analogous results between a door-open (*hands-free*) condition and a door-locked (*hands-occupied*) condition. Second, Southgate, Chevallier, and Csibra (2009) have demonstrated that infants will imitate the sliding/hopping behavior of the mouse if they are given prior knowledge that the mouse "belongs" in the house. That is, by changing what toddlers

[27] After 18 months infants were found to imitate using their head equally across the *hands-occupied* and *hand-free* conditions. For Gergely and colleague, this transition marks a developmental shift from the *teleological* stance to an *intentional* one. Those who argue that the infant of 18 months is already operating with an intentional stance generally ignore this finding.

already know about the situation, they can get over-imitation from a play situation as well.

Lyons' proposal implies the need for theoretical analysis regarding observational learning in general and imitation research in particular. The current critique of his proposal is intended to demonstrate just how badly that analysis is needed. Further, as long as the degree of fidelity between model and subject is the foundation for imitation research, the focus will always be on behavior and not on underlying cognitive dynamics that eventuate in that behavior. This attitude is further reinforced by not taking into account the developmental transitions that occur for the same tasks over time. Finally, defining imitation and emulation in terms of fidelity means that they are somewhat arbitrary (what is a means for one researcher is an end for another) and so it will always be possible to selectively attend to those results that fit with ones proposal to the exclusion of those that do not.

How Does Selective Imitation Relate to Emulation?

Lyons (2009) is quite right to point out that over-imitation (in the sense of repeating causally unnecessary/irrelevant steps) has only been demonstrated for tasks involving novel tools/artifacts as well as highlighting that different imitation tasks involve different domains. But part of the reason for the former is that the behavioral differentiation of selective imitation from over-imitation is typically only going to be possible for situations that involve multiple actions with objects. A similar point was made about emulation - that emulation alternatives are typically only testable in situations that involve complex actions on objects (Huang & Jiang, 2006; Thompson & Russell 2004; Want & Harris, 2002a).

However, emulation alternative interpretations were directed against purported evidence for 'true' imitation (imitation involving the attribution of mentality to the model) and demonstrate that leaner interpretations of what infants are cognitively capable of are sufficient to account for the data[28]. The more general role that alternative emulation interpretations have played for developmental psychology is not to deny the meaningfulness of the child's understanding in a given situation, but rather to explore alternative, non-mentalist possibilities for the nature of that understanding. That is, these interpretations have implicitly challenged the presumed split between the meaningless movements of objects and the meaningful actions of intentional agents.

Herein lay the convergence with selective-imitation. That is, the power of selective imitation was to blow open what constitutes the imitators' understanding of the situation. What is missing from Lyons' analysis is the recognition that all imitation is selective. It is the child's cognitive and motivational capacities in conjunction with the current (and past) interactive context(s) that accounts for the imitative activity that takes place. With the developmental focus shifted away from mentalism, TOM, and the broader folk psychology debate, researchers have been able to re-consider the contexts in which imitation episodes occur. These are highly structured situations that typically involve all sorts of social richness and familiarity for the infant/toddler. These situations may or may not involve learning, and that learning may be about the world or the modelers themselves. The methodological consequence of the broader emulation and selective imitation perspectives is reflected in the variety contextual and child-focused

[28] See Noble and Todd (2002) for a general discussion of leaner interpretations.

factors that contemporary researchers are exploring. Importantly, these factors go beyond the mentality and fidelity of the modeled actions.

The Child's Understanding of the Situation: Beyond Imitation Versus Emulation (i.e., beyond mentalism).

There have been two major realms of exploration concerning how children's understanding of the situation influences those aspects of the model's behavior that get copied. The first concerns what children know about the world, about objects in it, and how they interact with each other. The second concerns the model as a social partner and the role that they play in structuring the situation. Correspondingly, the richer and more flexible the child's understanding of the situation becomes, the less it makes any sense to see imitation as driven by some innate motivation to identify (Meltzoff & Tomasello). In contrast, the more imitation is seen to also have a social component, the less it makes any sense to see imitation as driven by some innate motivation to learn from ostensive demonstrations (Natural Pedagogy).

The role of world knowledge for understanding the situation. Let us begin with the first realm of exploration (world knowledge). Knowledge about objects, their properties, and the world will involve general knowledge from the past as well as more specific knowledge regarding the current situation. Brugger et al. explored how 15-month-olds' prior physical knowledge can be used to determine what actions of a modeled demonstration are relevant for understanding how to achieve some salient result (Brugger, et al., 2007). This study had four conditions which all involved a 2-step sequence on an object to produce a salient result. In the *necessary* condition both steps in the sequence were relevant for completing the task. In the other three conditions, step 1

was irrelevant for completing the task, but the irrelevance was progressively more salient across these conditions: first, in the *unnecessary* condition the object was reconfigured such that the first step was no longer causally relevant for completing the task; second, in the first *off-object (remote)* condition, step 1 took place on a spatially separated object followed by step 2 on the original object; third, in the second *off-object (body)* condition, step 1 was replaced by an action on the experimenter's body (e.g., patting their head) followed by step 2 on the original object.

The overall results demonstrated that infants produced the first step most often when it was causally necessary (the *necessary* condition) to achieve the salient result. Interestingly, there was progressively less imitation for the first step as the "obviousness" of its causal irrelevance increased. Specifically, step 1 was produced occasionally in the *unnecessary* condition, hardly ever in the *off-object (remote)* condition and never in the *off-object (body)* condition. These results suggest that the degree of certainty regarding the infant's knowledge about physical causality is playing an important role in producing these results. That is, physical separation was a sufficiently strong aspect of the infant's causal understanding of the situation that they were virtually unwilling to consider the possibility of its relevance for achieving the salient outcome.

In contrast, infants in the *unnecessary* condition were not as willing to dismiss step 1. That is, despite preferentially producing step 1 in the *necessary* condition, infants were unwilling to omit step 1 as thoroughly in the *unnecessary* condition as they were in the *off-object* conditions. Brugger et al. used these differential results across the three irrelevancy conditions to explore the possibility that infants will utilize the model as a resource to help guide them during periods of uncertainty. That is, will infants make use

of the social signals of the model for situations in which they are experiencing some degree of uncertainty about what they should be doing.

Study 2 also used 2 step sequences and had four conditions: two necessity conditions (*necessary/unnecessary*) and two social conditions (*socially-cued/not-cued*). The results indicated that infants produced the greatest amount of imitation of step 1 when it was both necessary and socially cued. In contrast, they showed the least amount of imitation of step 1 when it was unnecessary and not cued. An intermediate amount of imitation for step 1 was shown in the other two conditions. These results conform to the prediction that infants make use of the social cues (in addition to their physical knowledge) that are typically provide by the model in an imitation situation to guide them in their evaluation of relevance. Study 1 and 2 together are suggestive of the possibility that infants are especially open to social cues when they are *uncertain* about the relevance of some aspect of the demonstration.

The role of social factors in understanding the situation. Imitation situations usually involve a socially interactive demonstration and recent studies have looked more explicitly at the role of social engagement/cues on the child's willingness (selection) to imitate the modeled actions. Previous research has demonstrated that from 18-months, children can make use of imitation as a means of sustaining social engagement with others (Asendorpf & Baudonniere, 1993; Nielsen & Dissanayake, 2004). While these studies illustrate the extreme end of the social function that imitation *can* serve (i.e., imitation as strictly instrumental to the maintenance of social engagement), other researchers have been more interested in the role that social aspects contribute to the child's *selection* of what to imitate when they are focused on learning something new

about objects in the world (Johnson, Booth, & O'Hearn, 2001; Kiraly, 2009; Nielsen, 2006; Nielsen, Simcock, & Jenkins, 2008).

Johnson et al. (2001) studied 15-month-old infants to explore the role of sociability, broadly construed, in their replication of Meltzoff's (1995) reenactment procedure using a puppet orangutan. While clearly not human, the orangutan puppet possessed a number of the morphological and social properties associated with intentional human activity (e.g., face and hands, self-generated movement, contingent interaction with infant and experimenter). These properties were sufficient for the 15-month-old infants to engage in the same pattern of imitative activity that was found in Meltzoff's original study.

Nielsen (2006) investigated how changes in infant age, changes in situational constraints, and the sociability of the model can interact to modulate the fidelity of inefficient/unnecessary imitation of the means used to open a box. In this "key-and-box" procedure the model demonstrates how to use an unusual "key" to open a box that is more obviously and easily opened with one's hands. The results from experiment 1 indicated that 12-month-olds preferentially used their hands to open the box rather than the key, while 24-month-olds faithfully imitated the inefficient /unnecessary means (i.e., using the key) even though that meant that they were often unable to get the box open. Finally, 18-month-old infants displayed both the inefficient/unnecessary means (over-imitation) as well as the use of their hands (selective-imitation/emulation).

Experiment 2 manipulated the situational constraints using the same key-and-box procedure as in experiment 1 except that in the *failed-hands* condition the model first attempted (unsuccessfully) to open the box with their hands – the subsequent use of the

"key" could then be interpreted as the necessary reason for using it to open the box. The effect for 12-month-olds was substantial in that they preferentially imitated using the key in the *failed-hands* condition over the standard key-only demonstration. While in experiment 2 18-month-olds did not benefit from the new *failed-hands* condition (i.e., they imitated the use of the key equally between conditions and at levels comparable to the standard key-only demonstration in experiment 1), in experiment 3 18-month-olds preferentially imitated the inefficient means (using the key) when the model was socially attentive versus socially *aloof* (e.g., no "introductions" before testing, chronic pre-occupation with reading a book, no eye-contact). Unexpectedly, for 24-month-olds, this differential effect was limited to their *success* in opening the box but did not extend to their *attempted* use of the inefficient means. That is, while social aloofness did not differentially impact whether 24-month-olds attempted the inefficient/unnecessary means to open the box (as it did with 18-month-olds) it did contribute to whether or not they *persisted* in their use of the inefficient means and thus their ultimate success rate.

In a follow up to experiment 3 Nielsen et al. (2008) used the same key-and-box procedure with 24-month-old infants to further investigate the role of sociability during the imitation of inefficient/unnecessary means. The study manipulated the social contingency of the model using a video demonstration (either pre-recorded/no contingency or via closed-circuit/normal contingency). Their results indicated that the crucial variable is not whether the model is presented live or on video, but rather whether the model interacts with the child in a *contingent* manner. That is, interactive contingency seems to be a necessary aspect of sociability for 24-month-olds to imitate the inefficient/unnecessary means of opening the box.

Nielsen's results are important for a number of reasons. First, his cross-sectional design extended over a large enough range allowed for the demonstration of important differences across age groups. In general, when a procedure has been replicated with older children, the typical pattern is one in which lower fidelity matching (selective-imitation/emulation) gives way to higher fidelity matching ('true' imitation or mimicry). Using the same task with 12-, 18-, and 24-month-olds, Nielsen also demonstrated a transition from lower fidelity to higher fidelity but in a situation where the increased fidelity included an inefficient/unnecessary action (using the key). That is, infant's performance changed from selective-imitation/emulation at 12 months to faithful over-imitation at 24 months with an apparent transitional period around 18 months. Infants in the transitional period differed from the earlier stage in that they ignored the situational constraints. Interestingly, ignoring situational constraints at around 18 months is consistent with the findings from Gergely (2003) using their rational imitation task (Gergely, et al., 2002).

Second, the transitional period around 18 months seems to involve something about the infants burgeoning understanding of their social partner in imitation situations. Uzgiris (1981) argued that while imitation in infancy is primarily concerned with the cognitive function, there is a transition at around 2 years of age in which the primary function of imitation concerns interpersonal engagement. Building on Uzgiris, Nielsen investigated the complementary social function of imitation – specifically, the motivational aspect of the social function (i.e., those situation in which the *purpose* of the matching behavior is primarily to maintain the social interaction).

The use of a procedure that involves inefficient/unnecessary means is crucial for Nielsen's broader theoretical purposes. If the means demonstrated are transparently inefficient/unnecessary, then presumably the motivation for using them cannot be primarily based on learning how to complete the task. Further, the fact that the 12-month-olds were able to figure out that they could use their hands to open the box suggests that the relationship between the alternative means (using hands) and outcome (opening the box) were transparent to the child. In other words, the box was familiar enough to 12-month-olds that they were able open it with their hands after observing the required transformations on the box. This result is problematic for Lyons' (2009) analysis of over-imitation in terms of cognitive opacity. It makes no obvious sense to suppose that 12-month-olds are able to compute the informational significance of where to switch from imitation to emulation but 18- and 24-month-olds are not. However, Nielsen et al.'s (2008) appeal to Uzgiris' framework doesn't seem quite right either because the propensity for inefficient-imitation in the *non-interactive* video condition was already quite high – it was just greater for the *interactive* video condition (~3 versus ~2.5 out of 3).

Over-imitation: The Birth of a New Phenomenon.

The power of selective imitation as a phenomenon derives from its normative contrast with the idea of "blind" imitation in which infants copy the model's actions precisely. Recall that infants in the *hands-occupied* condition of Gergely et al.' (2002) procedure did not imitate the head action as often as those in the *hands-free* condition. These infants incorporated the *physical constraints* of the activity into their understanding of the situation and *selectively* copied what they saw in order to activate

the light-box (i.e., "the head is being used because their hands are occupied not because I am suppose to use my head also"). In contrast, over-imitation concerns situations in which infants not only copy precisely what is demonstrated for them, but also replicate actions that are "clearly" not necessary/relevant for achieving the ostensible goal of the activity. That is, the power of over-imitation as a phenomenon derives from its normative contrast with what is causally necessary/relevant to achieve some outcome using an artifact/tool. Over-imitation is even more interesting in light of the fact that chimpanzees (pan troglodytes) seem to be more able to use what they know about causal relations to avoid copying unnecessary/irrelevant actions on artifacts/tools than are toddlers.

Early examples of "over-imitation". The study by Nagell et al. (1993) is often cited as one of the earliest examples of over-imitation[29]. Their comparative analysis used a version of the two-action method to conclude that chimps are naturally prone to emulate while 2-year-olds are inherently imitators. Young children and chimpanzees were compared with respect to their use of a rake to retrieve an object. The relevant findings indicated that infants maintained high fidelity to the actions of the model for both the efficient and inefficient demonstrations of how to use the rake. In contrast, chimpanzees used the more efficient means of retrieving the object regardless of the demonstration. These findings were interpreted as indicating that the chimpanzees were more focused on the end result and functional relation between components (emulation) while children

[29] However, their experiment is more similar to Nielsen's (2006) in that it concerns inefficient imitation rather than the imitation of causally unnecessary actions on novel artifacts (over-imitation).

were more focused the specific actions of the model (imitation), even to the detriment of their success (because the inefficient means were less successful).

In response to Nagel et al.'s (1993) claim that chimpanzees are emulators, Whiten et al. (1996) conducted a study implementing the two-action method using an "artificial fruit". Their artificial fruit was a Plexiglas box with a latch and bolts on it that could be twisted or poked. Their results indicated that chimpanzees will copy the inefficient actions of a model; however, unlike young children, this imitative tendency disappears once the chimpanzees discover (either from practice or by accident) that there is a more efficient means to the end result. That is, chimpanzees seem to engage in selective imitation when they encounter new information about their situation whereas young children either do not discover the new information (more efficient means) or continue to imitate in spite of it (over-imitation).

"True" over-imitation. While the two studies mentioned above are often cited as early examples of over-imitation, their focus was on the imitation versus emulation debate and utilization of the two-action method required that the "unnecessary/irrelevant" actions involved were *inefficient* means to an end and not causally unnecessary/irrelevant actions per se. In order to directly test whether chimpanzees and young children would imitate causally unnecessary/irrelevant steps in a sequence of actions Horner and Whiten (2005) added a causal-transparency manipulation to their artificial fruit procedure. The general procedure used an artificial fruit box that was divided into two sections: access to the top half was through a hole in the top of the box and access to bottom half was through a hole in the base of the box. The demonstrated sequence involved using a stick to remove a bolt covering the top hole, the stick then stabbed through that hole three

times (these were the unnecessary/irrelevant actions). After removing the stick, a door covering the base hole was opened and the stick was inserted into a tunnel in an effort to "fish" out a piece of food (these were the necessary/relevant actions). The transparency manipulation was implemented with two conditions: In the *opaque* condition the internal division that separated the top and bottom was not visible because the box was colored. In the *clear* condition the box was fully transparent (except for the tunnel concealing the food) and the internal division was visible.

The authors originally predicted that both chimpanzees and young children would adaptively switch their pattern of copying according to the transparency of the box. Specifically, in the *opaque* condition the authors predicted that both chimpanzees and children would imitate all actions in the sequence because they would have no basis for determining which actions were necessary/relevant and which were not. In the *clear* condition, visibility of the division between top and bottom compartments of the box would indicate that the stabbing activity in the top of the box was unnecessary/irrelevant to obtain the food and skip this portion of the demonstration. However, only the chimpanzees conformed to the predicted pattern of behavior across the two conditions. In contrast, the 3-year-olds continued to imitate the unnecessary/irrelevant actions in the beginning of the sequence despite the revelation in the *clear* condition that the activity on the top of the box was not causally necessary/relevant for retrieving the food at the end of the tunnel in the bottom of the box. Importantly, over-imitation persisted in spite of the experimenter exiting the room in an effort to eliminate any social pressure to imitate.

Why Over-imitation is Interesting.

Two factors contribute to the "surprising" findings from Horner and Whiten (2005) that 3-year-olds (but not chimpanzees) continue to imitate with high fidelity despite visible evidence that the stabbing action is causally unnecessary/irrelevant in the *clear* box condition. First, our intuitions suggest that the *clear* box conditions provides adequate information about how the box works such that the stabbing action should be understood as causally unnecessary/irrelevant and therefore ignored (the behavior of the chimpanzees further suggests that this intuition is reasonable). Second, infants between 12- and 18-months of age have demonstrated the ability to adaptively *select* what aspects of a demonstration to copy on the basis of their understanding of the situation (Brugger, et al., 2007; Carpenter, et al., 1998; Gergely et al. 2002; Meltzoff, 1995; Schwier, et al., 2005; Southgate, et al., 2009; Williamson & Markman, 2006). However, both of these factors (our intuitions regarding experimental design and extant demonstrations of selective imitation) may be misleading.

Our intuitions about causal transparency. First, it is not at all obvious that the *clear* box condition should be expected to provide sufficient "evidence" that the stabbing action is not to be copied. The internal workings of the box cannot be considered in isolation from the imitation situation as a whole. The situation includes a social partner and involves all sorts of novelty in addition to what is familiar. The child is in a new room with an unfamiliar model that is initiating a familiar routine of turn taking on an unusual novel object. The experimenter provides a demonstration for how to interact with the object and ultimately retrieves a reward before telling you that it is your turn. Importantly, it is the imitation situation as a whole that is going to contribute to the child's evaluation of the additional "evidence" provided in the *clear* box condition.

To help motivate the relevance of the imitation situation as a whole, consider a situation in which a teenager starts their first job washing dishes in a restaurant. On their first day, the teenager is trained on how to use an industrial size dishwasher. They are instructed how to clean the filter if the water drains, how to unplug the spray rod when it clogs up, to make sure that plates do not have cheese on them before going through the machine, and to always clean the chef knives by hand. Part way through the shift the new employee is asked by one of the cooks to run down stairs and get the banana peeler for the chef right away. After asking a few other employees where exactly to find the banana peeler the young dishwasher returns empty handed with an exasperated claim that he/she does not even know what a banana peeler looks like. By this time all of the cooks are having a good laugh and chef is barking for everyone to get back to work.

Is the behavior of the dishwasher surprising? Not if you have ever worked in a restaurant. The point of the story above is that despite being able to reflectively discuss how the idea of a banana peeler makes no sense[30] given common knowledge about bananas and peelers, the dishwasher's efforts are typical. Even if there is some doubt about the plausibility of the existence of a banana peeler, the new employee, learning all sort of new routines and operations is unlikely to explicitly question the existence of the banana peeler implicitly presupposed by the cook's request. This example is not meant to illuminate exactly what is going on in the over-imitation situation of the 3-year-old and their activity on the artificial fruit but rather to question the intuition that the *clear* box

[30] Even if you could devise a contraption to peel bananas, it is hard to imagine that it would be faster to load the device and initiate the mechanical peel than it would be to do it by hand. Further, the number of bananas used by a restaurant would have to be unbelievably large to make the investment worthwhile.

condition should be sufficient for 3-year-olds to not copy the initial part of the action sequence.

Does selective imitation contrast with over-imitation? The second factor contributing to our interest in over-imitation (and why it was a surprising finding) is that 12-18-month-olds have demonstrated the ability to adaptively *select* what to copy on the basis of their understanding of the situation (Brugger, et al., 2007; Carpenter, et al., 1998; Gergely et al. 2002; Meltzoff, 1995; Schwier, et al., 2005; Southgate, et al., 2009; Williamson & Markman, 2006). However, all of these examples involved simple actions on objects. In contrast, the artificial fruit device is much more complex and unusual. Further, selective imitation of the type illustrated by Gergely et al. (2002) has not been demonstrated after18-24 months of age and anytime the same task has been used with older children they display a transition from selective to higher fidelity copying (Brugger et al., 2007; Gergely, 2003; Huang, et al., 2006; McGuigan, et al., 2007; McGuigan & Whiten, 2009). The implication of this is that the situation and type of causal knowledge provided by the transparency of the box may be importantly different than what is involved in the extant examples of selective imitation.

Along these lines, Want and Harris (2002) have suggested that the capacity for the type of emulation (selective imitation) that involves understanding and coordinating causal knowledge (what seems to be required for "success" in the over-imitation tasks) does not emerge until around 4-years of age[31].

Testing Our Intuitions About Causal Transparency.

[31] While this might seem to imply that over-imitation should disappear at around this age, the claim is only that the capacity for this type of causal reasoning becomes possible.

In an effort to establish whether 3-year-old's over-imitation behavior was a consequence of some sort of age-related cognitive limitation regarding the causal relevance of the *clear* box condition, McGuigan et al. (2007) set out to replicate and extend the findings from Horner and Whiten (2005) with a larger sample of 3-year-olds and a group of 5-year-olds. Contrary to their prediction that 5-year-olds would adaptively incorporate the causal information presented in the *clear* box condition, these children showed even more over-imitation than did the 3-year-olds. Further, the apparent trend of increasing over-imitation with age seems to continue on into adulthood (Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009). Finally, 3-year-olds failed to over-imitate in a video demonstration where only the model's hands were visible. Together, these results suggest that over-imitation involves more than just the causal relevance of certain actions for retrieving a reward. Whiten and colleagues speculate that over-imitation is probably best understood as an artifact of a human strategy for learning that is, in general, successful. In their words: "imitation is generally such a highly adaptive strategy that it may frequently be employed by young children in situations where it is locally inefficient to do so" (p. 363, McGuigan et al., 2007).

Trying to Explain Over-imitation (Lyons).

The basic idea that over-imitation is an artifact of a generally useful learning strategy is, fundamentally, the same perspective as what was advocated by Lyons (2009). While Whiten and colleagues are silent about the scope of over-imitation (i.e., whether across domains or not), and only implicitly suggest an evolutionary basis for it, Lyons proposal explicitly highlights the fact that over-imitation is restricted to novel

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Further, the central point being made is about the adequacy of appealing to these other

artifacts/tools and borrows an interesting evolutionary account provided by Gergely and Csibra (2005, 2006) for why that might be the case. Further Lyons et al. (2007) have attempted to explain over-imitation at something closer to the level of underlying cognitive processes rather than just reify the phenomenon of over-imitation into an explanation of its occurrence (i.e., children over-imitate because they have a tendency to imitate).

Lyons et al. (2007) argue that the reason purposeful demonstrations within the domain of tools/artifacts can result in over-imitation is a consequence of the child *encoding* all the model's actions as "causally meaningful". Subsequently, the "resulting distortions in the children's causal beliefs are the true cause of over-imitation" (p. 19751). Again, despite Lyons et al.'s efforts to model the underlying cognitive process that manifest as over-imitation behavior, there are serious limitations to their account.

First, children did not seem to be copying the model's *actions* at all. The authors point out that children did not differentially copy the method modeled for them but rather imitated at the level of object transformations only (including the unnecessary/irrelevant ones). Accordingly, within the imitation emulation framework, the results from this study are better characterized as over-emulation rather than over-imitation (Whiten, et al., 2009).

Second, what is the nature of this 'encoding' process (i.e., encoding all the model's object transformations as causally meaningful), and how does it relate to learning in general? Specifically, why are the child's causal beliefs impervious to the "transparent" visual information about the causal relations of the objects? And, how do

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studies as contrasting examples of selective imitation not what explains over-imitation.

these casual reasoning process eventually allow the child to move beyond the purposeful demonstrations of the model and learn about the "true" causal structure of the objects?

Finally, how does the nature of our causal belief system *develop* such that it can account for demonstrations of selective imitation followed by over-imitation on the same objects for different age groups (Brugger et al., 2007; Gergely, 2003; Huang, et al., 2006; McGuigan, et al., 2007; McGuigan & Whiten, 2009).

What is overwhelmingly missing from this causal-belief account is what the child has learned about interacting with adults in imitation type situations. Lyons et al. (2007) ground their dismissal of "social" factors in their findings from some follow up experiments. However, before introducing these follow up experiments consider the basic procedure of the main experiment.

Main procedure and results. In an effort to demonstrate the robustness of the "causal distortions" and rule out strong social and task demands the authors provided children with a training phase. In this part of the experiment the model demonstrated how to retrieve a toy from a *familiar* transparent container but they included some unnecessary/irrelevant actions as well. For example, the experimenter tapped the side of a plastic jar with a feather before unscrewing the lid to retrieve a toy. After the demonstration children were asked to identify the actions that the experimenter "had to do" versus those actions that were "silly".

After extensive training and feedback the children were given the test phase. This part of the experiment consisted of demonstrations on three *novel* "puzzle objects". Some of the demonstrated transformations were causally unnecessary/irrelevant, while others were required in order to retrieve the toy. The main result indicated that children

copied the unnecessary/irrelevant object transformations in addition to the necessary/relevant ones despite their "causal transparency" and the extensive training program. Following this basic result of over-imitation the authors provide three follow-up experiments to reinforce their "causal encoding" interpretation.

First follow-up experiment. First, they tried to eliminate any implicit social pressure from the experimenter that might have motivated the children to imitate the unnecessary/irrelevant object transformations despite knowing that they were causally unnecessary/irrelevant. The authors tried to accomplish this by emphasizing the relevance of the toy target and re-construing the method of achieving that target as purely instrumental. Toward this end, the experimenter feigned not knowing if their assistant had put the toys back in the puzzle objects and asked the child to check while they prepared paper work in another room. Over-imitation decreased for all three puzzle-objects but this trend was significant for only one of them. The author's highlight the fact that there was still far more imitation in this condition than was found in a baseline control and that the memory load of the experiment may have reduced reproduction of irrelevant actions.

At best, this follow-up condition is meaningless and at worst it speaks against Lyons et al. claim that distorted causal representations are to blame for over-imitation. First, the authors assume that their manipulation puts a premium on the time taken to open the puzzle objects – motivating the child to open the box as quickly as possible; however, while the instrumental motivation may remove any implicit social pressure to conform it also puts a premium on success. Given that the children are dealing with a relatively unfamiliar object and that they have just learned a new procedure guaranteed to

produce success, it is not at all clear that the instrumental manipulation should remove their motivation to repeat the procedure that is certain to succeed.

Second, the memory explanation, if correct, speaks against the author's proposal. There is no extraneous memory load distinct from the memory processes involved in learning the procedure in the first place. If irrelevant/unnecessary actions are eliminated from the memory representation of the procedure for opening the puzzle objects then clearly not all of the model's object transformations were encoded as causally meaningful. The more likely interpretation is that children learned from the additional trial. In fact, the puzzle object with the statistically significant reduction in imitation of unnecessary/irrelevant actions was likely to be the most familiar (i.e., it was similar to the transparent puzzle box used by Whiten and colleagues). With greater familiarity comes less uncertainty about how different transformations relate to each other and it may be that the right amount of uncertainty enables the possibility of learning (i.e., learning that some of the actions were irrelevant, more on the role of uncertainty below).

Second follow-up experiment. The second follow-up experiment used to test the "causal encoding" account builds on the original training phase using an explicit warning to only copy the necessary transformations. After receiving the standard extensive training, one of two "puzzle objects" are brought out. However, before the demonstration part of the test phase, the experimenter re-performs the simplest of the earlier training items (the feather and jar) and tells the child "I want you to watch really carefully, because when I open this [puzzle object], I might do something that's silly and extra, just like the feather". After demonstrating how to open the "puzzle box" the child was

reminded one more time "don't do anything silly and extra, okay? Only do the things you *have* to do" (p. 19755).

There are two inter-related problems with this training manipulation. First, the training phase is intended to illustrate the abstract notion of causally unnecessary/irrelevant actions that can then be applied to the imitation situation involving the novel "puzzle objects". However, there is an abundance of research that has demonstrated the difficulty that even adults have with standard analogical reasoning problems (Gick & Holyoak, 1983) and this difficulty of mapping what is learned during "training" to a test phase has been demonstrated specifically in an imitation situation (Croner & Willis, 1961). Further, the training may have made necessity/relevancy judgments even more difficult than it would have been without them (i.e., the training provided deep dissimilarities between base and target). Specifically, the type of irrelevancies[32] used in the training phase were perceptually and conceptually quite different than those used in the testing phase. Tapping a feather on the side of a plastic jar does not transform (or penetrate) the object in any way; whereas, in the testing phase the irrelevant actions almost all involved (5 out of 6) perceptually salient transformations of the "puzzle objects". Categorically, feathers are quite different from the tools used to operate on artifacts and from artifacts themselves. Telling the child to look for silly things "just like the feather" may have been more misleading than helpful.

The second related problem with the training manipulation concerns the potentially quite different internal states of the child when being presented with familiar

[32] Some results by Flynn (2008) are suggestive of the idea that children are sensitive to degrees of irrelevancies. In this study children continued copying the more plausible

objects versus unfamiliar novel objects. Consider that the ability of a cook to get a *veteran* dishwasher to seek out a banana peeler is highly diminished given both his comfort and familiarity with the job. Similarly, there are important differences in the child's understanding of the situation depending on whether the objects being used are familiar or novel. The degree of certainty in what they are learning and even their openness to learning is going to differ for familiar and novel objects in familiar and novel situations. The point is not that familiar objects cannot be used to learn about new ones, but rather that understanding of a situation is going to depend on prior knowledge and what is understood in a novel context might make seemingly similar tasks importantly different. That is, if two tasks are already familiar they may be understood differently than if one is familiar and the other new and this difference is going to depend on the internal states of the system.

Third follow-up experiment. The third follow-up experiment used to reject "social" factors and reinforce a causal reasoning interpretation of over-imitation looks at the impact of manipulating a causal principle. The authors suggest that if over-imitation is a consequence of the child engaging in a "social game" or an "innate motivation to copy others' actions" then violating a causal principle should have no impact on the fidelity of that imitation. Specifically, the authors considered how demonstrating irrelevant actions that violated the contact principle (no action from a distance) would effect the tendency of children to imitate those actions. In one condition the model demonstrated an unnecessary/irrelevant action on one of two puzzle boxes connected by a plastic tube to another puzzle box on which they performed a necessary/relevant action

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movement of a bolt transformation than the less plausible tapping of a stick, to achieve

that enabled them to retrieve a toy. In the other condition the plastic connecting tube was removed. The pattern of results was similar to what was found between the *necessary*, *unnecessary,* and *off-object* conditions used by Brugger et al. (2007). Recall that they found progressively less fidelity of imitation as the plausibility of their actions decreased (from the latch that blocked the lid - necessary, to the latch did not block the lid but was on the same box – unnecessary, to the latch that was on another box altogether – off-object). Similarly for Lyons et al., there was more copying of the unnecessary/irrelevant action when the tube connected the two puzzle boxes than when they were spatially separated.

Clearly these results say something about the role of physical contact and causal reasoning. However, the authors appeal to the contact principle as part of "core knowledge" – a regularity that "even 3-month-olds are sensitive to" – and assume that it is uniformly true. The contact principle is violated in all sorts of situations involving inanimate objects and this is especially the case for artifacts (e.g., a train passes by outside my window and the objects on my bookshelf shake, I flip a switch on the wall and the lamp across the room turns on). What these situations require is being able to understand that causes can be perceptually hidden. If even 3-months-olds have knowledge about the contact principle, then what must be learned with development are those situations in which it does not apply – those situations that involve *hidden* causes. Lyons et al.'s did not use different age groups and so it is not possible to know if there is a developmental trend in how willing children are to include aspects of a demonstration that violate the "contact principle" for understanding causal relations.

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some outcome.

Summary. Lyons et al. set up a false, mutually exclusive, dichotomy between the cognitive and social functions of imitation and mischaracterize their opponents accordingly. They claim that other researchers "assume that children over-imitate not for theoretically significant reasons, but rather as a purely social exercise" (p. 19751). That is, over-imitation is an artifact of a social engagement. In contrast, their argument proposes that over-imitation is a consequence of "the overextension of a normally adaptive learning process" (p. 19751). That is, an artifact of cognitive learning processes. However, the cited researchers concerned with the social function of imitation have never argued that over-imitation, of the type[33] explored by Lyons et al., is a "purely social exercise". Nevertheless, the authors then rule out social *motivational* aspects as the cause of over-imitation and extend that conclusion to the social *function* of imitation activity in general. However, in addition to *motivational* aspects, the social function of imitation includes *cognitive* aspects (i.e., knowledge about the interpersonal exchanges that are inherent to imitation situations).

Ironically then, these authors provide some elaboration on the potential sense in which cognitive and social functions may interact to contribute to the phenomenon of over-imitation. Central to their account is the role of the *intentional* actions of the demonstrator – it is the demonstrator's purposeful actions that are automatically encoded as causally necessary. Further, they agree with other researchers about the crucial role of communicative intentions and relevant pedagogical cues. They even conjecture that

[33] Lyons et al. equivocate on their use of over-imitation. To compare themselves to Uzgiris, Nielsen, and Tomasello requires implicitly defining it broadly as imitation that is not strictly instrumental and then comparing it to their narrow definition of copying unnecessary object transformations of novel artifact demonstrations that are designed to be instrumental imitation situations.

over-imitation may increase with development as "socially derived inferences begin to play a larger role in causal reasoning" (p. 19756). Thus, whether knowledge about when and how to interact with social partners is inherited over evolutionary time or learned over developmental time, the results of Lyons et al. demonstrate that children seem to use the purposeful actions of adults as a guide to help them learn to successfully interact with novel artifacts.

The Limits of Over-imitation: Video Displays and Diffusion Chains.

The research reviewed above suggests that something about the child's knowledge (evolved or learned) regarding the *interpersonal exchange* with adults is essential for over-imitation in novel artifact situations. However, only a few studies speak to this directly through their failure to produce over-imitation in situations that are very similar to the standard paradigm (Horner & Whiten, 2005). First, evidence that the child's knowledge about interpersonal exchanges may involve a developmental transition around 4 years of age[34] comes from our earlier discussion of McGuigan et al. (2007). After demonstrating over-imitation for both 3- and 5-year-olds using the standard paradigm, they found that 3-year-olds failed to copy irrelevant actions in a video display where only the model's hands were visible. The 3-year-old's performance was contrasted with that of 5-year-olds who over-imitated in both the video and standard modeling conditions. Recall that Neilsen and co-author (2008) used a video display to demonstrate the essential role of contingency for 2-years-old's imitation of *inefficient* actions (i.e., opening the box with an awkward key). Whether contingency continues to

[34] Lyons et al. use of children ranging from 3-5 (mean age 4) make their empirical results potentially problematic.

play an essential for 3-year-olds in situations involving *causally unnecessary* actions will require future research.

Further, Flynn (2008) has used a diffusion chain paradigm to study the transmission of unnecessary/irrelevant actions on novel artifacts. The diffusion chain paradigm used in this study was similar in structure to the children's game of "telephone". The initial link in the chain was a dyad consisting of the adult model and child observer while subsequent links were dyads of children.

While previous diffusion chain studies have demonstrated a high level of fidelity across the entire chain for demonstrations of necessary/relevant transformations on novel artifacts (Flynn & Whiten, 2008; Horner, Whiten, Flynn, & de Waal, 2006), the current study saw a parsing of the unnecessary/irrelevant actions early in the chain. Specifically, while transmission was of high fidelity from the adult model to the first child, most of the unnecessary/irrelevant actions were parsed out in the transition from the first to second child. Further and contrary to expectations, this was the case for both 2- and 3-year-olds for both the opaque and transparent conditions.

These findings are particularly interesting given previous research on diffusion chains and over-imitation. It would seem that the presence of the adult model is essential for the transmission of unnecessary/irrelevant actions on novel artifacts from model to observer. Flynn offers three possible suggestions for why children were less likely to over-imitate from their peers. First, children may perceive adults as more knowledgeable and they may doubt the rationality of their peers. Second, they may view the adult as an authority figure who is in a position to set the interactive parameters of the situation.

Further, children may be less motivated, in general, to maintain this type of social interaction with their peers.

Selective Imitation in Older Children.

Want and Harris (2001; Harris & Want, 2005) explored toddler's selectivity with respect to different possible variations on the use of a tool. The basic idea was to look at situations in which variations on the use of the tool results in differential consequences. The authors used two experiments to explore how the corrective behavior of an adult model could be used to guide the toddler's selectivity regarding how to use the tool. Borrowing from comparative methodology, the first experiment used a variant of the "trap-tube" task. This procedure involved a clear plastic tube with a toy in the center. A stick was available to push the toy through the tube and out; however, at one end of the tube was an opening in which the toy would fall into a trap and be stuck. That is, the stick had to be inserted into the correct side of the tube in order to retrieve the toy. Importantly, children were given an opportunity to complete the tasks (i.e., get the toy) prior to the demonstration phase and the few children who succeeded were dismissed from the experiment. The remaining children were given a demonstration followed by 10 opportunities to retrieve the toy. After each test trial the tube was rotated 180° so as to require knowledge of the *causal relationship* between "tool" and target outcome in order to consistently succeed.

For experiment 1, the relevant manipulation concerned whether 2- and 3-year-olds were shown a *correct* demonstration only, or if they were first shown an *incorrect* demonstration with an exclamation of error from the adult (i.e., "Oops") followed by an *correct* demonstration. Results indicated that while both age groups *used* the stick, only

the 3-years-olds benefited from the *incorrect + correct* demonstration. That is, 2-year-olds were indiscriminant (i.e., 50/50) about which end they inserted the stick across both conditions. Interestingly, 3-year-olds were also indiscriminant for the *correct* condition but were correct about 75% of the time in the *incorrect + correct* condition.

In a second experiment, the authors designed a new task using a "Y-shaped" transparent tube and a marble. The marble could be dropped down either arm of the tube in an effort to dislodge a toy stuck in the lower vertical section; however, one arm was clogged with a block. That is, the marble had to be inserted into the correct arm in order to retrieve the toy. The experimental conditions were elaborated to include a *full correct*, *full incorrect*, *partial incorrect + correct* and a *full incorrect + correct* demonstration. The pattern of results were similar to that found with the "trap-tub" task. That is, only 3-year-olds benefited from the *full*[35] *incorrect + correct* demonstration while the 2-year-olds were indiscriminant (i.e., 50/50) across all four conditions. Also similar to experiment 1, 3-year-olds did not benefit from a *full correct* demonstration and they were equally indiscriminant for the *full incorrect* condition as well.

The proposed explanation for these age differences concerned what the children were able to learn about the causal relations between the tool used and the target object. In the conditions with indiscriminant success, children seemed to be imitating the adult at the level of their actions/object-manipulations without regard for the specific causal relations between those actions and the target outcome. The 2-year-olds seemed entirely unable to use observational learning to "understand the causal effects of those actions, other than that they served to produce the desired goal" in the case of the demonstration

(p. 441). As a consequence, 2-year-olds did not modify their actions in accordance with the changing requirements of the task (i.e., the 180° rotation). That 3-year-olds only demonstrated a robust casual understanding in the *incorrect + correct* condition suggests that they require an explicit demonstration of how variability in antecedent conditions will produce the differential consequent effects. When shown only how to succeed – *full correct* or only how to fail – *full incorrect*, 3-year-olds do not learn the causal relations involved and imitated the actions of the model without regard for the changing circumstances when the display was rotated 180°.

Subsequently, Horner and Whiten (2007) have used a slightly more difficult variant of the "trap-tube" task to test the limits of Chimpanzees' and young children's ability to learn from others' mistakes. Their task differed in that the trap was in the center of the tube (rather than on one end) and knowledge of causal understanding was tested by alternating the side on which the toy was placed rather than rotating the tube 180°. Contrary to expectations, their results indicated both 3- and 4-year-olds were indiscriminant (50/50) across demonstration conditions (i.e., for both *correct* and *incorrect + correct*) though they did benefit relative to the control group who only saw the experimenter run the tool over the top of the tube. Consistent with other studies (Huang, et al., 2006) some of the children in the control group imitated these irrelevant actions including vocalizations. Finally, the same procedure with 5- and 6-year-olds produce success at near ceiling across all conditions (including the control condition).

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[35] They also benefited in the *partial incorrect + correct* demonstration but not as much (approx 70% versus 85%).

These results indicate that 5- and 6-year-olds are able to achieve success on the task without any demonstration.

Similar to Want and Harris (2001; Harris & Want, 2005) these authors concluded that 3- and 4-year-old did not understand the causal relationships involved and as a consequence of this incomplete understanding tended to imitate the actions of the adult model. Finally, the behavior of the 5- and 6-year-olds suggests a trade-off between children's use of imitation with their understanding of the causal relationships involved such that as the latter goes up the former goes down.

Some Clarifications on Selective-Imitation and Over-Imitation.

Narrow and broad definitions of selective-imitation and over-imitation are often conflated within and across studies. The narrow sense of selective imitation derives from Gergely et al. (2002) and concerns the observer's *active* evaluation of the situation in terms of physical *constraints* in an effort to understand the *reason* for the adult's actions. However, since then it has also been used more broadly to discuss any situation in which the observer is presumed to incorporate their own knowledge (about the world or about the mind of the model) into their selection of what gets copied. Use of the term selective-imitation for the current paper will refer to the narrow sense.

The narrow sense of over-imitation derives from Whiten et al. (1996; 2005)[36] and concerns observers who copy object transformations that are unnecessary to achieve some outcome despite visibly available information about relevant causal relations. In contrast, the use of over-imitation in the broad sense includes situations in which the "unnecessary" actions are instead irrelevant, redundant, or more typically, relatively

inefficient. Further, the narrow sense of over-imitation has always involved object transformations on novel, unusual, artifacts in a problem-solving situation with older children. Use of the term over-imitation for the current paper will refer to the narrow sense.

Conflating the narrow and broad senses of these phenomena has a number of consequences. First, it obscures several potentially relevant differences in the types of situations involved in each form of imitation. Selective imitation (in the narrow sense) has only been demonstrated for infants between 12- and 18-months of age whereas over-imitation (also in the narrow sense) has only been demonstrated with 3- to 5-year-olds on tasks involving novel artifacts/tools. Finally, copying *inefficient* actions on simple artifacts/tools has been demonstrated with children in between those two age ranges. Further, when the same task has been used with both younger and older age groups, there is a transition from more to less selectivity. This developmental transition (from more to less selectivity) is difficult to reconcile if researchers are focused exclusively on the *cognitive* aspects of children learning about the *world* because older children should be more cognitively competent about the working of artifacts not less. Consequently, failing to address these issues removes any impetus to understand how imitation itself might involve learning and development over the first five years.

Second, failing to take the above differences seriously results in the false polarization of selective-imitation and over-imitation. Lyons (2009) too rejects this polarization but does so by rendering the two poles in terms of emulation and imitation and explicitly assumes a video-tape model of perception. For Lyons, the selectivity

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[36] Though the actual label "over-imitation" appears to have been coined by Lyons, et al.

involved is with respect to the level of sampling resolution, but this way of construing things ignores motivational aspects and obscures the fact that all imitation is selective. The question isn't why are children selective sometimes and not selective other times; but rather, why do they select this here and that there? The distinction between emulation and imitation makes more sense when discussing issues of ability and origins (Are chimpanzee capable of imitation?). If the *purpose* of a demonstration is to teach the child something about an object transformation, then also attending to the specific actions down to some level of detail would be mostly irrelevant and in general would show an inability to properly utilize observational learning techniques.

Third, being overly focused on the cognitive aspects (the ability and origins) of types of observational learning (emulation/imitation) ignores the motivational aspects that are indicative of the different types of situations involved in imitation research (problem-solving/social exchange/play/etc.). Further, blurring the details of any developmental transitions between selective- and over-imitation sidesteps a deeper tension regarding the "selectivity" of emulation and the "automaticity" of imitation. Selective-imitation is interesting because of its purported contrast with children's automatic copying tendency that they inherit from birth. Selective-imitation involves intelligent, active, evaluation of the situation and constitutes a developmental milestone; however, the return to automatic copying (over-imitation) after having developed such insightful social learning abilities seems difficult to reconcile with the earlier selectivity.

Finally, the conflation between narrow and broad senses of selective-imitation and over-imitation confuses issues concerning the social function of imitation. Both of

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(2007) and McGuigan, et al. (2007).

these phenomena highlight object focused relevancy judgments: relevance with respect to physical constraints for selective-imitation and relevance with respect to causal necessity for over-imitation. But not all imitation situations are strictly instrumental in this sense. Further, even strictly instrumental demonstrations involve a social context and interpersonal engagement. The unfolding of that social exchange is going to depend on what the child has learned about those types of activities.

Back to Development: Selective-Imitation and the Underlying Cognitive Dynamics.

Only by taking a developmental perspective seriously are researchers going to make progress in their understanding of imitation both in terms of the patterns of behavior and as a cognitive process. That is, a developmental perspective is going to apply to both the methodology and the theoretical proposals being tested. Killen and Uzgiris (1981), Harnick (1978), Neilsen (2006) Jones (2007), and Brugger et al. (2008) provide powerful demonstrations of why taking a developmental perspective seriously is important for researchers trying to understand the cognitive aspects of imitation activity in young children. Using the same procedures on multiple age groups can reveal patterns of imitation activity that are difficult to established with multiple independent studies. Further, the use of progressively differentiated versions of the same task can also contribute to uncovering patterns that are not otherwise revealed (e.g., Brugger et al. (2007) introduced progressively more irrelevant actions (e.g., irrelevant actions on the object versus on another object versus on the body) in an effort to establish what infant's understood about relevancy with respect to the situation).

Cognitive and social functions of imitation (including the cognitive and motivational aspects of each) cannot be studied in isolation from each other. Determining whether transitions in the types of actions that children preferentially imitate are, for example, a matter of cognitive capability or social motivation is going to require a developmental context. That Lyons et al. (2007) contrast their proposal with the positions of Uzgiris and Neilsen exactly confuses issues of capability (learning about novel objects) with issues of motivation (what Uzgiris and Neilsen were highlighting) and would not be possible from a developmental perspective that assumes changes in the underlying dynamics of the system.

In general, a developmental perspective forces researchers to consider how the meaning of the situation might vary for the child with changes in age and task difficulty and that this might have important implications for their imitation activity. These changes are going to depend not only on what the child has learned about the world (both physical and social), but they are also going to depend on the developing system itself. Harnick (1978) used a developmental approach with progressively more complex tasks to illustrate the relevance of the infant's understanding of the situation. Recall that in this experiment three different age groups preformed three progressively more difficult versions of the same task. The results demonstrated that each age group imitated irrelevant gestures and noises most often when the task was of "optimal" difficulty. However, difficulty was itself relative to age and so maximum irrelevant imitation was different for each age group. In sum, theoretical models of imitation cannot continue to ignore the internal dynamics of the child who produces the rich source of finding that have been uncovered by researchers who take a developmental perspective seriously.

Reliability and Selective-Imitation.

Trust research. Recent research on model reliability has explicitly explored children's selectivity of adult models on the basis of their apparent trustworthiness (Harris, 2007; Harris & Corriveau, 2011; Koenig, & Harris, 2005a,b; Pasquini, Corriveau, Koenig & Harris, 2007). "Trust" researchers have demonstrated that children will selectively avoid learning unfamiliar object labels/functions from an adult who has been unreliable in the past. The basic paradigm involves a familiarity phase, in which children are introduced to two adult models, and a test phase, in which they must select which adult to learn from. In the familiarity phase, children observe both adults name familiar objects with either the correct or an incorrect label. In the test phase, children are exposed to an unfamiliar object and asked which of the two informants they would like to seek help from in learning about the new label/function (the ask question). Irrespective of their answer, both informants provide their unique label/function for the object and the child is asked which label/function they think the object is called/used-for (the endorse question).

Results from the above studies indicate that there are important developmental differences between 3- and 4-year-old's selectivity. While both age groups selectively trust (ask and endorse) accurate informants over ignorant or inaccurate informants, 3-year-olds are much less robust in their selectivity[37]. First, 3-year-olds show greater difficulty demonstrating selectivity for accurate over inaccurate informants than they do

[37] In fact, it was originally concluded that 3-year-olds did not differentiate between accurate and inaccurate informants but only accurate and ignorant informants (Koenig & Harris, 2005a, b). However, when the number of trials in the familiarity phase was increased from 3 to 4, 3-year-olds displayed selectivity for both ignorant and inaccurate

for accurate over ignorant informants while 4-year-olds show equal selectivity for accurate over both inaccurate and ignorant informants. Further, 3-year-olds show zero tolerance for inaccuracy. That is, unless informants are 100 % accurate, 3-year-olds do not differentiate them from informants with any amount of inaccuracy (i.e., 0, 25 and 75 % accuracy were all treated equivalently). In contrast 4-year-olds demonstrate statistically sensitive applications of selective trust. That is, 4-year-olds differentiate between informants who are mostly accurate (75 %) versus less accurate (0 or 25 %) as well as between those who are always accurate (100 %) and anything less (0 or 25 %).

Imitation research. Williamson et al. (2008), discussed above, provide one of the few studies to explore the relevance of adult model reliability for young children in imitation situations. While their primary focus was on the impact of a difficult or easy prior experience, they also demonstrated the relevance that model success has for imitation selectivity. In their study, children preferentially selected the successful over the unsuccessful model to imitate in a well-defined problem-solving situation. Importantly, the use of the word *success* rather than *accuracy* is indicative of the focus on the outcome of the problem rather than the utility of the adult per se.

Schulz et al. (2008) also construe their exploration of model reliability in terms of success rather than accuracy and their findings also indicate that children prefer to use reliable models as well. Their primary interest concerned children's broader knowledge about causally deterministic versus probabilistically effective actions on objects but the structure of their procedure was very similar to that of the canonical trust procedure. For their study, the major difference was that children were not selecting between two

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informants (Pasquini, et al., 2007). The limitation of 3-year-olds was originally discussed

possible models that have proved accurate or inaccurate in the past; rather, they were selecting between one model and their own ability to explore[38]. When the model was only probabilistically successful (50 % accurate), children preferentially selected their own means versus when the model was deterministically successful (100% accurate) they preferentially selected the actions of the model.

Finally, Diyanni and Kelemen (2008) pitted the intentional cues of an adult model (*intentional* versus *accidental* selection of a tool) against the functional affordances of those tools to accomplish some task. The general finding for 2-, 3- ,and 4-year-olds was that they mostly ignored the model's intentional cues in favor of their own selection based on their own evaluation of the two tool's functional afforadances (*affordant* versus *non-affordant*); however, both 2- and 3-year-olds did show greater openness to the model's tool selection for an *inefficient* rather than a *non-affordant* tool. This latter progression seems to parallel the findings from Brugger et al. (2008) in which 15-month-olds showed progressively less imitation as the likely relevance of the model's actions, for accomplishing the task, decreased.

Reliability and selectivity: Trust research versus imitation research. The selective aspect of trust research is focused explicitly on using *adults as a resource* for information. That is, trust researchers are explicitly investigating what young children have learned about learning from adult models. A conceptual connection with earlier

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in the context of TOM development but additional research has not found a connection.

[38] These results and the broader trust literature suggest another non-mentalist alternative interpretation for Metlzoff's (1995) findings. If the adult model is construed as failing to accomplish a familiar outcome, then it would be expected that children would not use the actions modeled by that adult and instead rely on their own abilities.

emerging social referencing and attachment research[39] is fairly straightforward given that all three areas focus on what the child has learned about using adults as a resource for regulating their interactions in the world. The conceptual bridge with imitation research however is less straightforward. The selective aspect of imitation research is typically focused on potential interactions with objects. The apparent lack of unity between the selectivity of social referencing[40], attachment and trust research on the one hand and imitation on the other, derives in large part from the over emphasis on the cognitive function of imitation.

The cognitive function concerns situations in which the *purpose* of imitation is to learn something about how to act on object and any selectivity is with respect to alternative methods for acting on those objects. Compounding the problem is the fact that the exploration of the social function of imitation is ubiquitously limited to its motivational aspects (playing the imitation game). However, the cognitive aspects of the social function are exactly concerned with learned patterns of interpersonal engagement. For standard experimental paradigms, selectivity, with respect to the social engagement, is inherent in the context of the imitation activity itself. That is, children must have learned how, when, and why they should interact with adults in imitation situations for these types of situations to be useful for learning about the world. Finally, the general lack of a developmental perspective on imitation itself (i.e., that imitation itself involves learning and development) means that research has not been focused on how the way in

[39] See Corriveau and Colleagues (2009) for an empirical exploration of the links between trust and attachment.
[40] See Uzgiris and Kruper (1992) for a conceptual exploration of the links between social referencing and imitation.

which children use adults as a resource to learn about the world might itself change (i.e., the patterns of interpersonal engagement).

Natural Pedagogy.

Gergely, Csibra, and colleagues have provided a program of research that explicitly incorporates some of the child's knowledge about patterns of interpersonal engagement that is inherent in imitation situations (Csibra & Gergely, 2006; 2009; Gergely & Csibra, 2005; 2006; Gergely, et al., 2007). These researchers have argued that imitation situations typically constitute a richly structured communicative transfer of knowledge between individuals. They propose that this communication system, called 'natural pedagogy', is an evolutionary adaptation that enables the fast and efficient transmission of new, generic, and relevant cultural knowledge.

Pedagogy differs from other observational learning mechanisms in that it is uniquely qualified to solve a new learnability problem that arose from the evolution of tool use – how to learn which aspects of *observed actions* on artifacts are relevant without perceptually available information about the purpose. When the goal of acting on an artifact is cognitively transparent (perceptually available), the learner can apply 'simple' teleological reasoning to determine relevance. For example, primates can learn to use (and even modify) tools for situations in the here and now because they are able to reason about how object properties relate to perceptually available goals. However, when the goal of an action is not immediately available (i.e., cognitively opaque) determinations of relevancy are not possible using 'simple' teleological reasoning and other forms of social learning (emulation, stimulus enhancement, affordance learning, etc.) are "ill-suited, error-prone … too slow … and could not ensure sufficiently high-

fidelity" (p. 471; Gergely & Csibra, 2005). Gegerly and Csibra (2005; 2006) argue that the emergence of recursive tool use (i.e., using tools to make other tools) constituted precisely the type of cognitive opacity that would exert selective pressure for the evolution of a qualitatively new form of social learning – natural pedagogy.

> Natural pedagogy proposes that *relevant* cultural knowledge is acquired by the 'student' in virtue of the fact that it is being manifest by the 'teacher': Humans possessing cultural knowledge are naturally inclined not only to *use*, but also to *ostensively manifest* their knowledge to (and for the benefit of) naïve conspecifics, while the latter are naturally motivated to acquire such knowledge by actively seeking out, attending to, and being specially receptive to the ostensive communicative manifestations of the others (p. 472).

Essential to pedagogy is the active participation of both 'teacher' and 'student'. This requires methods for setting up the situation such that the knowledgeable adult is ready to 'instruct' and the ignorant student ready to 'receive' that instruction. A number of non-verbal ostensive cues can be used to establish that the child and adult are in a pedagogical situation. The most obvious of these is eye contact. Eye contact can be used to indicate the communicative intention of the adult to demonstrate relevant cultural knowledge as well as specify the addressee of the communicated message. Contingent responsivity, prosody (motherese), and the child's name are three other ostensive cues that can be used to establish that the adult has something relevant to demonstrate.

Having specified that the situation is one in which the infant will have an opportunity to learn some relevant, generalizable knowledge, the adult must ensure that the child is attending to the reference of this knowledge. The major nonverbal methods

of establishing communicative reference is to use gaze following, pointing, or some other means of increasing the salience of the object or event.

With the situation defined and the reference established, the child is ready for the teacher to make manifest the contents of the cultural knowledge transfer. However, the problem of relevance reemerges at the level of action *manifestation* just as it did at the level of action *observation*. The communicative intent of the adult manifestation is mutually understood as being produced for the benefit of the child to learn something new and relevant. Therefore the learner must "decode the teacher's manifestation with respect to his own knowledge" (p. 261; Csibra & Gergely, 2006), that which is new (unexpected) constitutes the relevant knowledge to be learned from the adult manifestation. That is, "the relevance assumption will dictate to the learner to attend to those aspects of a demonstrated tool use that he would not be able to infer from his existing knowledge … and conclude that he has been taught these novel aspects" (p. 268).

Finally, natural pedagogy proposes that learning in ostensive pedagogical cueing contexts requires that certain conditions in the social world are generally the case. Specifically, infants must *hold* three assumptions in order for pedagogy to work. First, the *co-operativity* assumption requires that there are in fact 'teachers' around to manifest relevant cultural knowledge and that the child will *trust* the teacher such that they do not need to attempt to verify the relevance of the acquired knowledge. The 'default' setting for this assumption is to universally trust everyone in every situation. What children must learn through experience is when to suspend this assumption.

The second assumption required for pedagogy to work is the *omniscience* assumption. This assumption presumes the existence and validity of all knowledge and is assumed to be available for manifestation at any time. With experience, children must learn the conditions that make people ignorant. Finally, the third assumption is a corollary of the second, which states that the acquired knowledge is public, shared, and generalizable. This *universality* assumption implies that all knowledge is publicly available to everyone. In particular, whatever the child has been taught will be shared knowledge with all others much as words are part of a shared sign system. Again, the child must learn when to suspend this assumption.

Natural Pedagogy and Selective Imitation.

From the natural pedagogy framework, imitation is understood as a means for pedagogical purposes. Gergely and Csibra (2005) highlight that typical imitation situations constitute rich ostensive communicative-referential cueing contexts. Experimenters typically establish eye contact and often address the child by name (ostensive cues). They typically draw the child's attention to a referent object through eye-gaze or pointing (referential cues) and a referential speech act (e.g., "Look, I'll show you something!"). The authors propose that imitative learning is actually triggered by the pedagogical cues that precede the *manifestation* of cultural knowledge.

Further, the induced 'pedagogical stance' contributes to the selectivity about what to imitate in that the child assumes that they are about to learn something *new* and *relevant* and therefore that it should be fast-learned (learned quickly without trying to *verify* the relevance). Determination of what is new/relevant requires that the child have a knowledge-base appropriate for setting up expectations/interpretations about the

situation. Those aspects of the demonstration that violate the expectations or are un-interpretable to the child constitute what is cognitively opaque and therefore is considered the *point* of the pedagogical demonstration. Children will then selectively imitate those aspects that they do not understand while ignoring those aspects that are fully interpretable.

Rational imitation. Gergely and colleagues have provided a *pedagogical* explanation that elaborates (Csibra and Gergely, 2006; Gergely & Csibra, 2005) on their original *teleological* explanation (Gergely, et al. 2002; Gergley, 2003) of the selective imitation findings from their modification of Meltzoff's (1988) light-box demonstration. Recall that Meltzoff's results indicated that infants would imitate a novel means for activating a light-box (using their head). Gergely et al. (2002) then modified the experiment by including an additional condition in which the model wrapped them-self in a blanket (*hands-occupied* condition) before using their head to activate the light-box. Results from this condition indicated that infants would not imitate a novel means for activating the light-box (using their head). Their explanation was that infants used their appreciation of the situational constraints (hands occupied by the blanket) to explain the head action and therefore that the head action was not the most rational/efficient choice given that their own hands were free. In the *hands-free* condition infants *did* copy the head action indicating that infants wanted to discover the situational constraints that made the head action the most rational/efficient means.

The differential result between the *hands-free* and *hands-occupied* conditions fits very nicely with the natural pedagogy framework. Pedagogical learning situations can be divided into three processing steps: 1.) they indicate that something *new/relevant* is going

to be demonstrated; 2.) the infant uses their knowledge-base (teleological interpretation of the demonstration) to determine what is *new* and therefore *relevant*; 3.) this new/relevant action is fast-learned as manifest by the infants' selective imitation. In both conditions, illumination of the light-box is *new* and is therefore incorporated into the infant's understanding of what has been manifested for them by the model. However, imitation of the means was selective and it is step (2) that explains why infants produce their differential responses across the two conditions. In the *hands-occupied* condition the infant can use their teleological reasoning to infer that the situational constraints are sufficient to "justify/create-an-expectation" that the model will use their head. That is, in the context of the situational constraints, the head action is not *cognitively opaque* and therefore does not qualify as part of the *new* information to be transmitted. In the *hands-free* condition the infant uses their teleological understanding of the situation to determine that the model's hands are the most rational/efficient means of turning on the light-box. However, contrary to expectations the model did not use their hands but preformed the unusual head action instead. In this condition the head action remains *cognitively opaque* and is therefore understood as part of what is *new*/*relevant* about the ostensive-communicative manifestation of the model.

The Interplay of Cognitive and Social Functions.

An essential difference between natural pedagogy and other forms of social learning (imitation, emulation, stimulus enhancement, etc.) is that natural pedagogy depends on the active participation of the adult model (Csibra & Gergely, 2006). It is a form of *communication* that involves the transfer of relevant cultural knowledge between individuals. Communication is itself an inherently social activity that requires

coordination between partners. While the child's knowledge for how to engage in this type of communicative activity is thought to be innate, it provides the basis for the sense in which natural pedagogy highlights the interplay between the cognitive and social functions of imitation. The purpose of pedagogy is to transfer knowledge about the world (cognitive function), but, as a form of communication, pedagogy also requires shared patterns of interpersonal engagement (social function). As a form of communication then, natural pedagogy illustrates the interplay between cognitive and social functions of imitation activity.

Nonetheless, natural pedagogy is not meant to be an account of imitation ability per se; rather, the capacity to imitate is construed as a "low-level" process (shared with many non-human species) that is claimed to have been recruited by the broader system of pedagogical knowledge transfer (Gergely & Csibra, 2005). Gergely and colleagues contrast their perspective on imitation with what they call "identification" proposals: in particular, the positions of Meltzoff and Moore (1977; 1989; 1997) and Tomasello and colleagues (Tomasello, 1999; Tomasello et al. 2005). For Meltzoff's theory, imitation behavior is a consequence of infants' innate motivation to identify with others who are "just-like-them". For Tomasello's theory, imitation requires understanding the intentions behind the others' actions that, in turn, requires a human-specific motivation to share psychological states. Accordingly, these theories are characterized as endorsing broad and narrow forms of identification respectively. In contrast, for pedagogy theory, identification does not serve any theoretical purpose (Gergely, 2003). That is, the innate motivation to identify, common to Meltzoff and Tomasello, is replaced by an innate

motivation to receive ostensive manifestations of *new* and *relevant* cultural knowledge from benevolent conspecifics (Csibra & Gergely, 2006; Gergely & Csibra, 2005).

Limitations of Natural Pedagogy.

The primary limitations of natural pedagogy derive from two of its main assumptions. In particular, the innateness of the infants' knowledge about ostensive communicative situations as well as the innateness of the efficiency/rationality principle that forms the core of the teleological/intentional stance (Gergely & Csibra, 2003). The first problem with these commitments is that both help to preclude considerations of the *motivational* aspects and complexities that are involved in imitation situations. The second problem is part of the first and is simply that they ignore the possibility that ostensive communication as well as determinations of relevancy might themselves involve *learning* and *development*.

Regarding motivational aspects, the efficiency/rationality principle is the basis for the infant's understanding of what to expect from a demonstration in a pedagogical situation. Specifically, the efficiency principle is the core of the teleological stance that enables the infant to coordinate situational constraints with the outcome of some action that then constitutes their teleological interpretation of that situation. That interpretation then becomes the basis for the infant's expectations. For example, in the *hands-free* condition of Gergely et al. (2002), the authors propose that the infant will *expect* the adult to use their hands to turn on the light box because it is the most *efficient* action for accomplishing the outcome within the constraints. In the *hands-occupied* condition, the authors propose that the infant will *expect* the adult to use their head because that is now the most *efficient* action given that their hands are occupied.

Instrumental motivation. Rendering action understanding in terms of efficiency (the teleological stance) and latter in terms of rationality (the intentional stance) implicitly delimits these action understandings to situations in which there is a robust normative contrast (i.e., efficient/rational with respect to 'X'). For imitation research this has typically manifest in terms of using well-defined "problem-solving" situations that involve actions on objects. Importantly, problem-solving situations also tend to induce instrumental motivations to achieve the "correct" result/goal, but postulating that the efficiency principle is the interpretative engine that drives selective imitation obscures the role of motivational aspects. That is, the intrinsic link between instrumental motivation and the efficiency principle, via problem-solving situations, allows pedagogy to unilaterally focus on cognitive aspects of imitation situations to the exclusion of motivational ones.

Why do children learn and what about learning to learn? With respect to the connection between motivational aspects and the innateness of ostensive communication, consider that in contrast to the broad and narrow identification perspectives of Meltzoff's and Tomasello's theories, natural pedagogy focuses on learning "from" rather than learning "about" other minds (Gergely, 2008). Accordingly, while Meltzoff's and Tomasello's theorizing require innate motivations to identify with others (in order to learn about their minds); pedagogy requires an innate motivation to learn from others (in order for ostensive manifestations to serve their cultural transmission function). If learning "from" others does not itself undergo learning and development, then no other motivational considerations are necessary. However, what seems to have been lost from the overwhelming focus on the broader mentalism debate is the possibility of learning

"about" other people (there's more to people than their minds) for the purpose of learning "from" those people.

Pedagogy is founded on the idea that adults can be a resource for children to learn about culture but it does not consider that how they are used as a resource might itself be learned. Learning about how to use an adult as a resource for further learning instantiates one of the senses in which the cognitive and social functions of imitation can be intertwined (i.e., learning about people in order to learn about the world). However, the cognitive and social functions of imitation have both cognitive (learning) and motivational (selection) aspects. The absence of any learning with respect to the social function and the disregard for the motivational aspects of both functions suggests that natural pedagogy is incomplete. Interestingly, a closer look at the data supports that conclusion.

The Devil is In the Data.

Children's first response is to use their hands. Pedagogy is intended to provide an explanation for the selective aspect of the findings from rational imitation (Csibra & Gergely, 2006; Gergely & Csibra, 2005; 2006). Recall that the ostensive communicative context and teleological action interpretation enable the extraction of what is new/relevant from a demonstration and indicate that it should be fast-learned. However, a consistent finding from all extant studies (that reported it) has been that infants in both conditions (*hands-free* and *hands-occupied*) first turned on the light-box with their hands. That is, children in the *hands-free* condition used their heads to turn on the light box more often than those in the *hands-occupied* condition, but only after they had already turn the light box on with their own hands.

In the original rational imitation experiment, Gergley et al. (2002) attribute the infant's use of their hand prior to their *selective* use of the head to an "automatic, emulation-like process". Further, in a subsequent book chapter, Gergely and Csibra (2006) suggest that the infants who went on to use their heads in the *hands-free* condition "were still motivated to reenact the model's demonstrated – although less-efficient – head action… This clearly suggests that imitative learning of novel actions is a qualitatively different process in human than … [in] other animal species" (p. 240). The implication of this explanation is the plausible claim that qualitatively different motivations are operative for human versus other species; but pedagogy theory offers no conceptual resources for how to discuss (let alone integrate) these different types of motivation. In sum, in an effort to avoid the limitations of identification perspectives on imitative learning, natural pedagogy may have gone too far in focusing on the cognitive aspects of the cognitive function of imitation. That is, pedagogy ignores the motivational aspects of both the cognitive and the social functions of imitation.

"Head-action" – broadly construed. In an effort to argue against "direct action matching" approaches to imitation that, create "motor copies" of the modeled behavior, Gergely (2008) points out that their studies on rational imitation only found about 10% of infants who preformed the "head action" actually used their heads as demonstrated by the adult (i.e., using their forehead). The other 90% showed large variability in the specific head response used to contact the light box: "kissing it, licking it, putting their ears on it, pressing their eye onto it, touching it with their cheeks or their chin and so on" (p. 185). Regardless of the implications for "direct action matching" approaches, these results seem problematic for natural pedagogy as well. That is, infants of this age are quite

capable of imitatively responding to actions that are more highly differentiated than at the general level of the "head area". Pedagogy argues that infants will selectively imitate those actions that are new and thus relevant, not that they will actively explore a variety of actions constrained to a certain region of the body.

The underlying problem concerns the issue of how determinations of what is new and relevant are made. Pedagogy relies on violations of "efficient" behavior (given the situational constraints) to decide what actions should be selectively replicated. But efficiency determinations are with respect to the outcome that the model is pursuing and the "playful" variability of the child's responding suggests that they are no longer interested in the outcome per se. Infant's already know that they can activate the light-box with their hands, that their subsequent use of the head-area involves so much variation suggests that perhaps they are not seeking out the unknown situational constraints that make the adults action efficient but rather that they are engaging in playful exploration (i.e., using the head might be fun). That this playful behavior is with respect to the head area certainly does imply that the demonstration had an impact on the infant's decision about what to do, but it would seem to be something more along the lines of body enhancement/priming rather than some form of imitation.

Finally, what is the model "really" doing in the *hands-free* condition? That is, what are the "actual" situational constraints that make the behavior the most efficient means to turn on the light-box? As an adult we might speculate that the person is paralyzed, that they began to faint and then recovered, or more likely, given the presence of the child, that they are being silly and playful. That infants too might have interpreted the demonstration as an attempt to be playful further illustrates the need to explicitly

consider motivational aspects of imitation beyond those intrinsic (i.e., instrumental motivation) to problem-solving situations.

Developmental transition at 18 months. An additional empirical anomaly for the pedagogical interpretation of the original rational imitation findings at 14-months (Gergely, et al., 2002) is that the same procedure with 18-month-olds fails to produce the selectivity that is found with the younger age group (Gergely, 2003). That is, 18-month-old infants imitated the unusual head action of the model with equal fidelity across both conditions (i.e., *hands-free* and *hands-occupied*). However, despite this difference in selectivity, the18-month-olds followed the same pattern of "emulation-like" behavior as the 14-month-olds who first used their hands to turn on the light-box. That is, the 18-month-olds also used their hands to turn on the light-box before using their heads.

Other empirical results: Cognitive limitation versus rational selectivity. The very phenomenon of rational imitation, as a selective capacity based on some sort uniquely human cognitive appraisal of the situation, has been thrown into doubt by a series of more recent results. First, Paulus, Hunnius, Vissers, & Bekkering (2011) point out that another crucial difference between the two conditions concerns whether infants are physically able to copy the exact actions of the adult model. Specifically, infants are unable to lean forward and touch the lamp with their head without using their hands as support (i.e., they are physically unable to copy the *hands-occupied* condition). The authors suggest that this inability constitutes the limits of potential actions in the infant's repertoire and consequently impacts what they are able to learn through imitation. Ultimately, they suggest that it is a cognitive inability that creates the "selective"

behavior across conditions rather than a rational appraisal of the situation for the purpose of engaging in pedagogy.

To test this alternative the authors created several other conditions, the most relevant of which are a *hands-up* condition and a *hands-occupied-but-still-on-the-table* condition. The results indicated that when the model had their hands up, children did not imitate the head action (something outside their repertoire but not explainable given the situational constraints); however, when their hands were occupied by holding in place two large balls on the table, infants did imitate the head action at rates comparable to their replication of the original *hands-free* condition.

Are dogs rational imitators too? To further complicate the rational, let alone pedagogical, interpretation of the original rational imitation results (Gergely, et al. 2002), Range et al. (2007) have demonstrated "rational" imitation in dogs. The structure of their design paralleled that of the original experiment. The experiment was explicitly designed to be an "instrumental problem-solving" task that utilized the dominant tendency of dogs to use their mouth. Accordingly, there was a *mouth-occupied* (situational constraints) and a *mouth-free* condition in which the demonstration-dog used its paw (unusual target action) to pull on a suspended loop that would release food. The results indicated that, similar to 14-month-old humans, dogs in the *mouth-free* condition preferentially imitated the unusual action of using their paw to pull on the loop. Interestingly, all of the dogs first engage the loop in mouth manipulations. This is analogous to the situation in which all 14-month-olds (in both conditions) first activated the light-box with their hand before preferentially using their head in the *hands-free* condition.

What about non-human primates? Finally, primate understanding of the "rationality" of human behavior has been explored both in terms of action interpretation (Wood, et al., 2007) and imitation (Buttleman, et al., 2007). The former group of researchers demonstrated that cotton-top tamarins, rhesus macaques, and chimpanzees are willing to incorporate the constraints of the situation into their interpretation of the actor's goal-directed behavior. Specifically, these primates preferentially searched for food at a location that was specified with the elbow when the model's hand were occupied versus when they available. Whether any non-human primate can then, use their rational interpretation of goal-directed action for imitative learning purposes, was investigated by the latter group of researchers.

Buttleman et al. (2007) explicitly based their procedure on the original rational imitation experiment (Gergely et al., 2002) but included additional unusual behaviors for activating the light-box. Their results indicated that enculturated chimpanzees preferentially imitated the model who used their head/elbow/foot/bum to activate the light-box in the *hands-occupied* condition versus the *hands-empty* condition. Together these results suggest that non-human primates are capable of both teleological action interpretation as well as selective rational imitation.

In sum, the above three sets of empirical results raise some serious doubts about the *cognitive* aspects of the pedagogical interpretation of the original selective imitation findings. If selective performance by human infants requires the model's hands to specifically be on the table and if dogs and non-human primates are also capable of demonstrating what has been interpreted as rational imitation, then perhaps the selective

aspect of "rational" imitation is more about cognitive learning and development (or rather their limitations) than the uniquely human adaptation for pedagogical knowledge transfer.

Gergely and Csibra (2005) are careful to claim that their evolutionary account and empirical support for natural pedagogy are independent of each other. But problems for their evolutionary account has the implication that "pedagogical knowledge transfer" might itself involve learning and development that is not directly tied to ancestral tool use. Specifically, the restriction of pedagogy to only "problem-solving" situations (with underlying instrumental motivations) and its reliance on the efficiency/rationality principle for determinations of relevance is intimately tied to its theoretical commitment that there be some evolutionary account of natural pedagogy. The alternative is to suggest that major features of natural pedagogy are learned or fall out as a consequence of development that is not anchored to an innate rationality principle.

"Why" Do Children Want to Learn from Adults: Back to Learning and Development.

This is the last subsection of empirical results to be discussed and it will be used to suggest that perhaps the ostensive communicative contexts that constitute pedagogical situations involve important motivational aspects that are learned and develop throughout early childhood. The major point of contrast for Gergely et al. with other imitation researchers is the identification aspect that is ultimately concerned with learning about the mental lives of other people. Accordingly, they reject the innate motivation to identify with others and replace it with an innate motivation to *acquire ostensively manifested knowledge*. However, the uniformly found result from rational imitation experiments on humans (and also reported with dogs) is to first activate their own

familiar means of engaging the object. A strictly instrumental perspective is not adequate to capture the observer's sequence of behavior (hands before head, mouth before paw) nor their repeated engagement of the modeled behavior (Zmyj, Daum & Aschersleben, 2009). Further, an adequate account of the developmental transition at 18-months is likely to involve cognitive as well as motivational changes.

Abused children and imitation: Differing motivations. A study by Zigler and Yando (1972) builds on their notion of *outerdirectedness* which is defined as a style of problem-solving that relies on concrete situational cues, rather than abstract relationships. Their previous research has explored how a child's prior experiences with intellectual success or their interpersonal exchanges with adults as social partners can alter their willingness to utilize adults as a resource. This willingness is understood to have both cognitive and motivational aspects and the authors use an imitation paradigm to explore the latter. The idea is that "socially deprived children of average intellect [will] have experienced such negative treatment by adults that they become suspicious of adults and the cues they provide" (p. 415). The relevant findings indicated that the younger institutionalized children imitated less than non-institutionalized children. However, when exposed to an unsolvable problem-solving task, the institutional effect disappeared. Together these results were interpreted as indicating that institutionalized children had little choice but to utilize the adult if they wanted to solve the problem but that they actively avoided utilizing the adult's cues when there was not the additional motivation to solve a problem.

The relevance of this research is twofold. First, it highlights the importance of the underlying motivational aspects that are involved in different types of situations; and

second, how motivational aspects are going to interact with the patterns of interpersonal activity have been learned throughout development.

CHAPTER 3: THE INTERACTIVIST APPROACH TO IMITATION

The selective aspect of rational imitation redefined imitation research by focusing attention on the child's understanding of the situation in ways that did not involve mentalism. Previously, it was assumed that infant's possessed an innate tendency to *identify* with other conspecifics and this was the basis for their "automatic" tendency to imitate. Accordingly, researchers explored how the variables involved in reading others' minds (identifying) guided imitation performance in ways that were selective relative to the assumed default of "precise" behavioral copying. In contrast, natural pedagogy assumes that infants possess an innate tendency to *receive* culturally relevant knowledge and this is the basis of their tendency to selectively imitate. Accordingly, researchers have explored how the variables involved with the communication of new and relevant knowledge guide imitation performance in ways that are selective relative to the similarly assumed default capacity to copy behavior "precisely".

The current point is not simply that there are many factors that contribute to imitation activity, though that may be true, but rather to recognize that all imitation activity is selective and that the type and degree of fidelity involved is going to depend on both the cognitive and motivational aspects of both the cognitive and social functions of imitation. To build on an earlier point about motivation in general, the question is not why is the infant's imitation activity sometimes selective and sometimes not; but rather, why is the infant's imitation activity selective in this way rather than in that way? The answer to this question might emphasize cognitive over motivation aspects or cognitive over social functions, but models of imitation activity need to acknowledge these different factors to appropriately situate their experimental results. Further, these factors

will all depend on (and interact with) the purpose(s) of the model in providing the demonstration in the first place[41].

For example, if the selectivity involved in the light-box experiment constitutes more of a cognitive limitation than a motivational imperative to learn what is new and relevant, then the selectivity involved in that case is going to be importantly different from the selectivity that is involved in a play situation where the cognitive capabilities of the child are not in doubt. It is only by abandoning the tendency to define cognitive mechanisms in terms of fidelity (e.g., imitation versus emulation) and the underlying commitment to a video-tape model of perception upon which it is based, that researchers are going to be able to integrate and model the mental complexities involved in different *types* of social learning situations.

Consider that the motivation to identify with others and the motivation to learn from others may constitute distinct motivations that, in conjunction with cognitive capabilities, may dominate in different types of imitation situations. Further, given the relevance of cognitive capabilities for motivational aspects in general (i.e., what is interesting depends on cognitive level) these identification and learning motivations are not going to remain constant (nor do they need to be innate). Infants and young children learn many things about adults (not involving mindreading) and that knowledge has the potential to influence their motivation to identify with or learn from adults in general.

Recognizing that imitation situations are always selective (and selective in different ways depending on the situation) highlights the relevance of both the child's cognitive and motivation capacities. Adopting a rich developmental perspective

[41] This aspect disappears for situations that involve 3rd party (or non-solicited) imitation

highlights the relevance of children's current (and past) interactive social context(s) that are typically present in imitation situations. That is, interpersonal exchanges involve coordination between participants and a developmental perspective recognizes the relevance of what has previously been learned about those shared patterns of social activity. Together, these insights suggest a conceptual space in which the identification perspectives of Meltzoff and Tomasello, as well as the pedagogical perspective of Gergely, might be situated.

Nonetheless, while this conceptual space might be consistent with these perspectives in certain respects there are also significant points of divergence. Regarding the identification perspectives (Meltzoff & Tomasello), the alternative framework[42] to be proposed will reject the role of mentalism for imitation situations in general. A strong claim will be made that the capacity to reason about the perceptually hidden mental states of others is not even possible until around 3.5- to 4-years of age. Further, the presumed innateness of both the motivation to imitate and the capacity to imitate (Meltzoff) or the partial developmental account of that capacity (Tomasello) will also be rejected in favor of a fully developmental approach to these issues. Regarding pedagogy, the modeling resources of the teleological-representational framework will be supplanted by the interactivist model of representation. These modeling resources will be used to show how pedagogy constitutes a special case of children's ability to use other people as a resource for subsequent learning. Finally, the shared patterns of interpersonal activity

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(for some exploration of 3rd party imitation see Herold & Akhtar, 2008).

[42] From this alternative perspective, infant and toddler identification does not involve mental states but rather is constituted by shared presumptions about the types of interactive potentialities available to each participant (for elaboration see Bickhard, 1980a, 2004).

involved in imitation situations will be modeled in terms of learning and development (rather than evolution) in ways that are derivative from the interactivist model (Bickhard & Terveen, 1995).

The next section concerns a new theoretical framework for understanding the nature of cognition and action. While the modeling resources of the information-processing framework of the cognitive revolution was an improvement over the cognitively impoverished ontology of behaviorism, its own fundamental inadequacies mean that it is equally in need of revolt (Allen & Bickhard, *in press*; Bickhard & Terveen, 1995; Brooks, 1991; Marken, 2009; Spencer & Schoner, 2003; Thelen & Smith, 1994; Port & vanGelder, 1995). The current theoretical framework derives from an action-based model of representation that shares certain affinities with Piagetian theory but also one that has important differences (Bickhard & Campbell, 1989).

The Interactivist Model of Representation

At its core, interactivism is a model of representation (Bickhard, 1995; 2009a,b) that has been developed and expanded so as to provide a more global ontology for understanding "the whole person" (Bickhard, unpublished manuscript). Interactivism shares with Piagetian theory in its concern for the origins of knowledge and both theories consider action as the necessary foundation for understanding mentality in general. Consequently, from the interactivist perspective, mental representation is emergent from action and anticipations about potential interactions constitutes the core of all representation. This anticipatory, action-based perspective on representation is in contrast to standard *encoding* models. Encoding models represent in virtue some sort of

correspondence relationship between the organism and the world (e.g., informational, causal, teleological, etc.)

Encodingism.

Encodingism is the assumption that foundational representations are encodings (Bickhard & Terveen, 1995). Encodings are representational stand-ins that possess an epistemic connection with what they represent. However, they posses that connection, as well as their content, only in so far as some epistemic agent is present to provide it to them. That is, an encoding requires an epistemic agent to provide both its content as well as its connection (in the world) to what it is being used to represent (Campbell & Bickhard, 1986). Bickhard's canonical example of a conventional encoding relationship is the Morse code correspondence relationship (e.g., "…" stands-in-for "s"). Morse code is useful because dots and dashes can be sent across telegraph lines while characters cannot; but in all cases, the encoding relationship requires an epistemic agent to provide the representational content to the characters (e.g., "s"), the pattern of dots and dashes (e.g., "…"), and the stand-in relationship between them (e.g., "…" means "s"). "In other words, encodings change the *form* of representations, but borrow the *content* from elsewhere, which entails that, in order for encodings to have content, that content must already be available elsewhere (p. 560; Bickhard, 2009b)".

The need for encodings to have their content supplied to them from an external epistemic agent is precisely the implication of Piaget's copy theory argument. Piaget argued that our knowledge of the world could not be understood as somehow a copy of it precisely because one would need to already have knowledge of the original (the world)

in order to make the copy; however, knowledge of the original is exactly the same problem all over again.

Epistemic contact versus epistemic content.

Encoding models are assumed to posses their content in virtue of a correspondence relationship with what they are taken to represent. These correspondences often take the form of a causal relationship between the object in the world and neural activity in the brain (via transduction – changes in the form of energy). However, assuming that causal correspondences constitute representations of what those correspondences are with conflates the causal capacity to *detect* with normative knowledge of what those detections are about. Everyone will accept that the thermostat's sensitivity to temperature constitutes an ability to detect differences (between above set point temperatures and below set point temperatures) but that the thermostat does not have representational knowledge regarding what those detections are about – temperature. That is, despite the thermostat's sensitivity to temperature there is no representational knowledge involved. For the thermostat, it is agreed that detection does not constitute representational knowledge of what those detections are about. For humans, the potential to *also* have representational knowledge of what some detection is about is of course possible; but for encoding models, representational knowledge is assumed to be constituted by the detection itself. That is, encoding models inherently conflate a crucial distinction between epistemic contact (detection, differentiation) and epistemic content (knowledge, representation).

Interactive differentiation.

Bickhard and Terveen (1995) provide a model of interactive differentiation that captures our epistemic contact with the world. Consider that any interaction of a system with its environment will depend in part on the nature of the system and in part on the nature of the environment. As such, the internal outcome state of the system (after the interaction with the environment) will serve to categorize those types of environments that leave the system in that internal outcome state from those that leave it in some other internal outcome state. For simplicity, consider a system that has only two internal outcome states, A and B. Interactions with certain environments will leave the system in internal outcome state A while interactions with other environments will leave it in outcome state B. Thus internal outcome states A and B serve to differentiate A-type environments from B-type environments. Importantly, the system has no knowledge of the environments that it has differentiated and consequently "... detection of an A-type environment is just differentiation, not a representation" (p. 574, Bickhard, 2009b).

Epistemic contact with the world in terms of internal states of the systems has the crucial benefit that these states are system accessible. Their accessibility means that they can be useful to the further functioning of the system and useful in such a way that is intrinsically sensitive to the current environment. It is through the indication for potential further functioning of the system that representational content is emergent from interactive differentiation. Bickhard (2009b) elaborates on the emergence of representational content from differentiated contact:

> It might be learned, or hard-wired, for example, that, if state A is encountered, then an indication of the possibility of tongue flicking and eating of a particular sort can be set up. Such an indication is future oriented, anticipatory, and,

therefore, involves content: it is about the current environment, and it could be true or false. But, to reiterate, setting such an indication up should be contingent on having engaged in a prior differentiating interaction with the right kind of internal outcome (p. 574).

Implicit presuppositions.

Anticipations about potential future interactions can proceed as expected or not – anticipations can succeed or they can fail. This is the sense in which the interactivist model of representation accounts for truth-value. Importantly, the anticipated interactions are premised on the prior interactive differentiation of the environment. Therefore, actually engaging in one of the anticipated interactions implicitly presupposes that the environment is appropriate to support the interaction. If that anticipation is false and the interaction fails, then the implicit presupposition was in error. For example, when a frog differentiates its environment as indicating an opportunity to flick its tongue and eat, actually engaging in the tongue flicking implicitly presupposes that the differentiated environment is one that actually affords an opportunity to eat (e.g., there is a fly). If instead the environment was one in which there was an experimenter throwing pebbles, then the anticipation is false, the interaction fails and the presupposition is in error. That frogs do in fact eat pebbles in these situations indicates that they do not differentiate between flies-type environments and pebbles-type environments. That is, the implicitly defined opportunity-to-eat environments are differentiated at something like the level of small-object-moving-across-the-retina.

The notion of implicit presupposition is powerful because it enables researchers to model implicit knowledge without that knowledge being explicitly *represented*. Further,

it resonates with research observations about behavior that accord with some principle but seem unlikely to be known or represented by the infant or young child. Conversely, not having some way to model implicit knowledge has lead to extravagant claims about what infants and young child "know" (explicitly represent). For example, researchers (Spelke, Breinlinger, Macomber, & Jacobson, 1992) have argued that, because an infants' looking behavior differentiates two displays that are consistent with the "principle of solidity", that they have knowledge of that principle as part of their innate core knowledge.

Object representations.

Much of contemporary developmental psychology has accepted the previously established nativist interpretation that the object concept is an innate primitive – part of the innate foundation for the rest of knowledge. From an anticipatory perspective the object concept must be constructed and therefore must itself involve learning and development. The interactivist perspective on object representation borrows heavily from Piaget's action-based model of the object concept as an organization of invariant action potentialities. That is, object representation is *constituted* by a web of interactive potentialities that remains invariant under some class of further transformations (Bickhard, 2009b).

Once developed, the object concept is foundational in the sense of providing an anchor point from which to explore and learn about other *relevant* transformations. That is, the general organization of anticipations that constitutes the permanence of objects remains invariant under certain transformations (e.g., displacement) but not others (e.g., burning). Crucially, which transformations are deemed relevant is going to be discovered

through children's own exploration and through observational learning. In general, learning will exist both with respect to the web of invariants themselves as well as for the relevant transformations.

Interactivism and Natural Pedagogy

With respect to imitation research, Csibra and Gergely (2006) claim that "pedagogical knowledge acquisition also relies on *implicit* assumptions about the world" (p. 269, italics mine). Recall that the three assumptions were: *co-operativity* – that there are teachers available and that they can be trusted; *omniscience* – all knowledge can be manifest at any time; and, *universality* – that acquired knowledge is publicly shared, like words. Recall also that children must learn when to suspend each of these assumptions: when not to trust; when people are ignorant; and, when knowledge is idiosyncratic.

How these assumptions are known by the child is not specified; although, it is the case "that an infant must *hold* [them] in order to take advantage of pedagogy" (p. 269, italics mine). From the anticipatory perspective of interactivism, these assumptions are implicit presuppositions. That is, the anticipated interactions in pedagogical situations implicitly presuppose that there is an all-knowing teacher who can be trusted to manifest publicly shared cultural knowledge. Learning when to suspend these assumptions is a matter of greater differentiation – much like the frog learning to not eat pebbles would require greater differentiation. Further, the reason that the *co-operativity* assumption is initially "applied 'by default' to everyone in every situation" (p. 270) is because that is the level of differentiation at which the implicit definition is constituted. That is, the infant's differentiation of environments (types of situations involving other people) is

such that they anticipate potential interactions that presuppose a "trustworthy"[43] partner. Recall that Zigler and Yando (1972) argued that the reason that the institutionalized children in their study imitated in the problem-solving situation was precisely because their prior experiences had lead to a differentiation of situations in which they do not "trust" adult social partners.

The interactivist model of representation also converges with the insightful work that Gergely and colleargues have done on the use of ostensive/referential-communicative cues to indicate pedagogical situations in the first place. From an anticipatory perspective, these cues constitutes relevant aspects of the child's capacity to differentiate pedagogical situations from others types of situations. It is clear that these cues differentiate situations at a level that is broader than just pedagogy (i.e., ostensive communication can indicate situations other than pedagogy); but within that differentiated space, pedagogy is one of the types of situations of which young children have a rich structure of anticipations about interactive potentialities. However, in contrast to natural pedagogy, neither the general functioning of the cues nor the situations that they indicate need to be innate. There may be innate scaffolds[44] regarding attention

[43] In its most rudimentary form, the sense of trust that we are talking about may be something as general as whether or not the social partner fulfills their "obligation" in some routine. The still-face procedure (Tronick, Als, Adamson, Wise, & Brazelton, 1978) is an example of violating such an "obligation".

[44] Use of the term "scaffolds" is non-canonical (Bickhard, 2005). Its use here can be understood as a *functional* analogue to constraints from within standard approaches (encoding perspectives) in the sense that both allow learning that would not otherwise be possible. That is, scaffolds are to action-based constructivisms what constraints are to hypothesis-formations/inductions. In both cases they enable learning to take place: however, for the latter, constraints are suppose to *narrow* the space of possible hypotheses/inductions that could be generated; while for the former, scaffolds *enable* constructions that would not be generated on their own. The major representational difference is that scaffolds and constructions are not required to be constituent elements

preferences (e.g., a preference for eye contact) but the differentiations themselves and the indicated situations almost certainly involve learning and development. From this perspective, the atypical imitation behavior demonstrated by the institutionalized children from the Zigler and Yando (1972) study is not a "deformation" of the developmental process bestowed upon us by our ancestral past, but rather a consequence of developmental and learning processes functioning properly in a different type of environment.

Up to this point, the discussion of natural pedagogy from the interactivist perspective has basically been in terms of elaborative convergences; nonetheless, there are also some fundamental divergences. The primary divergence is pedagogy's commitment to the rationality principle at the core of teleological representations/interpretations. Put simply, the rationality/efficiency principle at the core of the teleological framework is not sustainable. Specifically, the rationality principle is the basis for determinations of relevancy; however, relevancies cannot be determined a priori as illustrated by the frame problems[45] (Heal, 1996). Relevancies must be learned

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of the things that they are scaffolds and constructions of – that is they are not necessarily homuncular (Bickhard, 1991).

[45] The frame problem originated from within the artificial intelligence community in connection with the exploration of how to program a robot to keep track of the consequences of its actions (McCarthy & Hayes, 1969). Some actions have obvious (typical) consequences; if I throw this ball outside, then its location will change; while other (atypical) consequences are more difficult to address. For example, if I throw this ball outside, its color will not change, the trees will not move, etc. These later consequences may be irrelevant but that such a judgment cannot be taken for granted is precisely the point highlight by the frame problem. Further the status of their relevancy can change given an appropriate context or history (the color of the ball may change if it is light sensitive, etc.). In Bickhard's (2001) discussion of the issue he says that:

> The general problem emerges from the fact that it is not a priori determinable what relevancies there are, or are not, between various actions or events and the multiple parts and aspects of the world … Instead any assumptions about such

from experience and only a robust notion of implicit representation is adequate to avoid the frame problems (Bickhard, 2001). The rationality principle is purported to establish relevance by setting up expectations about activity in the pedagogical situation (e.g., the *expectation* that the model use their hand to turn on the light box in the *hands-free* condition derived from that being the most efficient/rational thing to do). However, an anticipatory perspective would predict the same hand-use activity but without the need to appeal to any principle of rationality that governs behavior. The general difference between the use of expectation in the various literatures[46] and anticipation as it is understood in the interactivist framework goes back to the issue of encodingism. The content of an encoding is always explicit[47]. When researchers discuss expectations about the world (and their violation) it is always going to be in terms of explicitly encoded representations. That is, expectations are presumed to be based on representations (encodings) about the world. If I expect a billiard ball to move when struck by another billiard ball then I explicitly represent both balls, the relationship between them, and what will happen when one of them is struck by the other one. In contrast, the content of an anticipation is an indication of potential further interaction. Interactive anticipations are about the world in the sense that they make implicit presupposition[48] that can be "refuted" by the world but the world is not part of the explicit content of the anticipation.

> relevancies seem to be defeatable by appropriate contexts or histories … [further] attempting to represent and to compute all such relevancies and all of their defeating conditions is an unbounded task, and therefore, intractable. It cannot be done (p. 227).

[46] This includes the use of anticipation in the imitation literature as well as the notion of action-effects.

[47] This is why encoding models directly encounter the frame problems when dealing with relevance (Bickhard, 2001)

If I anticipate that a billiard ball will move when struck by another billiard ball then I have set up an indication about what types of further interactions are possible (e.g., I will be able to see the balls move along their trajectories, I can get excited about winning a bet, etc.).

The Inverted-U Learning Curve

Interactivism models the underlying cognitive dynamics of anticipatory representation in terms of a robust constructivism (Allen & Bickhard, 2011). In turn, constructive learning processes have properties that begin to account for some of the cognitive effects found in imitation research. In particular, experiments have demonstrated an increased *motivation* to imitate in situations involving an optimal degree of uncertainty. It was discussed earlier that children were more open to imitation of a model when a task was difficult but not too difficult (Harnick, 1978) or when they were given a difficult (rather than easy) experience prior to the modeling demonstration (Williamson, et al., 2008). Killen and Uzgiris (1981) have argued that this inverted-U learning dynamic persists throughout development in that infants and young children show a preference to imitate those events that are optimally difficult (not too familiar and not too novel). Kaplan and Oudeyer (2007) have provided a computational model that attempts to capture children's changing motivations for certain types of imitative behavior in terms of maximizing opportunities for new learning. Finally, it has long been documented that infants prefer to look at visual displays that are novel, but not too novel (Kagan, 1972; 2002). The present claim is that the inverted-U preference/learning curve

[48] The unboundedness of implicitly defined environment is why the interactivist model of representation does not encounter the frame problems (Bickhard, 2001).

present throughout development is itself a consequence of the uncertainty that is inherent in constructivist models of representation.

The Interactivist Model of Motivation

For endogenously active systems (i.e., living organisms), the general question regarding motivation must be selective "how does the system select what it will do" rather than energizing "what makes the system do something rather than nothing" (Bickhard, 2003). So the motivational question with respect to the inverted-U preference/learning curve is to ask why does the system prefer learning in situations that are novel/difficult but not too novel/difficult or too familiar/easy. The answer to this question is to understand these factors as vicariates for the uncertainty that is inherent in the constructive processes regarding potentialities for how to proceed in the current situation.

In novel situations the system does not have well-defined indications about how to proceed – that is why they are novel. However, the uncertainty associated with these ill-defined indications can themselves be anticipated as being resolvable or not. That is, the system may *not* know exactly how to proceed in a novel situation (creating uncertainty) but it *will* have anticipations about how that type of uncertainty will be resolved (e.g., successfully or unsuccessfully). Anticipations about uncertainty resolution (successful or not) form the core of the interactivist model of emotions: positive emotions are anticipations of the successful resolution of uncertainty while negative emotions are anticipations of the failure to resolve uncertainty (Bickhard, 2003).

Because the underlying dynamics of the interactivist models of knowing and learning stabilize constructions that are successful and destabilize those that fail

(Bickhard, 2003), the system will tend to "seek out" situations that involve uncertainty that is anticipated to be resolvable (i.e., the anticipations regarding uncertainty-resolution will be successful). Further, because destabilization (i.e., failure to anticipate successfully) induces learning processes, when children are put into uncertainty situations of the type that are anticipated to be resolvable, they will tend to be "open" to engage in relevant learning processes (i.e., difficult tasks, that are anticipated to be resolved, may induce imitation as a general heuristic for resolving that type of uncertainty). Uncertainty, then, is a crucial part of what characterizes the situation for the child. Further, uncertainty is going to contribute in both general and specific ways to the motivation (selections amongst anticipations, including learning processes) of that child.

Types of Uncertainty

Uzgiris and Kruper (1992) provide one of the few discussions about uncertainty with respect to imitation and social referencing. Uncertainties can relate to both objects as well as to people and they can be more or less well differentiated. First, it is possible to have uncertainty about the nature of the situation itself. This type of general uncertainty may be resolved through a *global* evaluation that is indicated by the presence of a trusted adult (i.e., attachment figure). However, uncertainty can be more specifically with respect to a particular object or event within the situation. For example, the child's exposure to a novel object might induce uncertainty about whether to approach, ignore, or actively avoid the object. This type of uncertainty could be resolved through a *communicative-referential* evaluation that is indicated by a facial expression or some aspect of a verbal expression (i.e., social referencing).

While the uncertainty involved in social referencing is specific to a particular object or event, it is still general in the sense of what is indicated (i.e., approach, avoid, etc.). However, when uncertainty is with respect to which specific interactions are possible/interesting, general evaluations (although specific to the object) will not suffice. This type of uncertainty could be resolved through an *action-specific* evaluation that is indicated with modeling (i.e., imitation). That is, the child "may seek guidance from another on *how* to interact with the object, not *whether* to interact with it" (p.119; Uzgiris & Krupper, 1992). Finally, it is possible to have uncertainty about the type of interaction expected by the other person. This type of uncertainty is resolvable through the utilization of previously acquired routines (e.g., peek-a-boo, imitation, general turn taking).

Uncertainty and Selective-Imitation: Subjective Uncertainty

Early research has demonstrated that for young adults, imitation responses vary as a function of both subject and model competence (Mausner & Block, 1957) even when that competence is manipulated during rather than prior to the task (Croner & Willis, 1961). More recently, Williamson et al. (2008) have explored how the prior experienced difficulty of the child and the observed success of the adult model can impact the child's selectivity regarding what and when to imitate. As with the earlier research on young adults this finding persisted even when difficulty was manipulated during rather than prior to the task.

Specifically, experiment 1 established the relevance of prior difficulty for subsequent imitation of an adult model. Children either had an *easy* initial experience or a *difficult* initial experience trying to achieve a well-defined goal on a familiar object

(e.g., open the drawer of a box to retrieve a toy). Following their divergent prior experiences both groups received the same demonstration (e.g., pushing a non-functional button to open the box) of how to easily accomplish the task. Results indicated significantly more imitation of the target act (e.g., pushing the button) for those children with the difficult initial experience than those with the easy initial experience.

In a follow-up experiment, all the children received the same difficult initial experience and demonstration (e.g., pushing the button) but only some of the adult models were successful at achieving the goal (e.g., getting the toy). Children preferentially imitated the target actions of the successful adult model after having a difficult prior experience. Finally, Experiment 3 demonstrated that infants would retroactively imitate a successful model after discovering that their previously successful strategy no longer worked. That is, children showed adaptive flexibility in how they made use of imitating the adult model within the same session. This finding suggests that children make presumptions of relevance and when these are falsified by an attempted interaction, children are willing to revise those presumptions by appealing to the previously ignored demonstration of the model.

More broadly, these results are a powerful demonstration of the importance that the internal readiness of the system can have on subsequent learning through observation. In a well-defined task the child will be instrumentally motivated to achieve the goal. Receiving specific feedback that their *general* knowledge is insufficient to achieve the goal seems to generate a need for the system to engage in some sort of learning process. Uzgiris (1981; Sibulkin & Uzgiris, 1978) has previously modeled this type of situation in which the infant's *general* knowledge required modification by utilizing Piaget's

perspective on imitation in terms of accommodation. Specifically, in the Williamson et al.' study, children's difficult prior experience can be understood as creating uncertainty in the anticipated outcome of engaging with a familiar type of object. This uncertainty becomes the basis for the child's exploration of alternative means to achieve the goal with the adult model as a potential resource for such exploration.

However, Experiment 2 demonstrated that selectivity also takes place with respect to how and when to use the adult as a resource. The child's *general* knowledge that adult's are typically a good resource for discovering things about the world in imitation situations was itself falsified in the *unsuccessful* demonstration condition of Experiment 2. This result suggests that the imitative learning processes initiated as a consequence of the original uncertainty created by the difficult prior experience do not apply indiscriminately. That is, children learn to differentiate some of the particulars for how and when to utilize the adult as a resource for information when experiencing their own uncertainty.

Interactivism As a Resource for Understanding Imitation Activity

Interactive differentiation, anticipatory representation, implicit presupposition, and the interactivist model of motivation provide the relevant modeling resources to begin exploring children's understanding of imitation situations from within the interactivist framework. From an anticipatory perspective, imitation functions as a resource for ongoing and future activity. This activity may involve interactions with objects in the world as well as interaction with other people. Crucially, understanding imitation activity as a means of utilizing others as a resource for further activity means that imitation itself is going to involve learning and development both in the sense of

what children are *able* to imitate (cognitive aspects) and in the sense of what they *select* for imitation (motivational aspects). Further, recognizing that imitation is necessarily general, refocuses our attention on the inherent selectivity of all imitation activity. The question of what exactly is being learned (if anything) from the observation of others is still central to this shift in perspective but the demarcation of different forms of social learning (e.g., mimicry, emulation, imitation proper, etc.) in terms of the degree of fidelity between model and subject is no longer the essential variable. Rather, the crucial differences between different forms of social learning are going to depend on the underlying cognitive processes involved – cognitive and motivational processes. Finally, a constraint imposed by an anticipatory (interactivist) conception of representation forces a conceptual exodus of mentalism from all imitation activity prior to 3.5-4 years of age[49].

Imitation is Inherently General and Inherently Developmental

Some elaboration on the sense in which the interactivist model motivates/accommodates a perspective in which imitation is inherently general and inherently developmental is in order.

Consider that imitation is always with respect to some level of abstractness. That is, the correspondence between model and child must be inherently general (e.g., at the level of the finger, the limb, the body, the object, the tool, etc.). Further, the particular level of generality at which children are *able* to imitate, is going to depend on the development of their cognitive processes and how those processes categorize the world[50]

[49] While the general constraint is logically forced, the specific age has been determined on the basis of empirical results (See Campbell & Bickhard, 1986).

[50] This situation also exists for adults with respect to expertise. For example an adult's ability to "perceive" will be limited by their own ability when observing expert

(importantly, this also includes what has been learned about presumptions of relevance given the type of situation). Similarly, the particular level of generality that children *select* for imitation, is also going to depend on underlying motivational processes; however, if motivation is understood as selections amongst anticipated possibilities, then there can only be selections with respect to the spaces of anticipated possibilities that are potentially being learned in the current situation. There is some sense, then, in which the cognitive aspects of imitation are most basic. Further, it is these cognitive aspects that capture both the necessary abstractness of imitation as well as highlight why imitation itself must involve learning and development.

If what the child is *able* to or *selects* to imitate depends on the cognitive processes involved with representing the world and these processes are rendered in terms of anticipation and interactive differentiation, then such processes are inherently general and inherently developmental. Regarding generality, recall that interactive differentiations do not specify the contents of what they differentiate but rather they implicitly defined *types* of environments in terms of possible internal states (e.g., interactions ending in internal state A implicitly define A-type environment versus interactions ending in internal state B implicitly defining B-type environments). These implicit definitions are unbounded and inherently general and therefore so too are the interactive differentiations. Further, the implicit presuppositions regarding environmental conditions appropriate to certain anticipations (but not others) are also unbounded and inherently general because there is no exhaustive list of such conditions possible. Therefore both *anticipation* and *interactive differentiation* are inherently general.

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performers (Calvo-Merino, Glaser, Grezes, Paasingham, & Haggard, 2005; Aglioti,

Regarding development, if representation is constituted by the anticipation of future potential interactions (on the basis of prior differentiation), then these must be learned. By actually engaging in such interaction, those that do not proceed as anticipated will fail and be selected out while those that do succeed will remain. Further, while the possibility that some differentiating abilities may be a consequence of maturation, others are surely learned (e.g., phoneme discrimination, reading sonar, X-ray analysis, chemical diagnostic testing). Therefore, if the ability to successfully engage in different *types* of interactions requires learning and development, then so too will imitation.

Learning About Types of Situations

From the interactivist perspective, organisms must, in general, learn to categorize different *types* of situations before they can learn how to be competent in them (differentiation prior to anticipation). With respect to imitation, in addition to learning *how* to imitate, children must also learn *when* imitation activity is appropriate. That is, they must learn about the different types of *situations* in which imitation activity could be useful for further learning about the physical and social world or perhaps when it would be an appropriate for play purposes[51]. Learning about the types of situations in which imitation is appropriate for further learning constitutes a form of meta-recursive learning that is an example of self-teaching (Parker, 1993) or self-scaffolding (Bickhard, 2005).

Other research has nicely illustrated how, for the infant, the rich social structuring of the adult's interactions can be used to indicate the type of situation (Csibra & Gergely,

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Cesari, Romani, & Urgesi, 2008).

2006; 2009; Gergely & Cisbra, 2005). Specifically, these researchers have provided a compelling case for the adult's use of ostensive-referential cues for the differentiation of communicative learning situations. The additional point being made here is that these cues might themselves involve learning and development. Further, the child's reliance on the adult to help differentiate types of situation will diminish and at some point, the child will be better able to actively "seek out" communicative learning situations for themselves.

Further, the selective aspect of imitation applies more broadly than these researchers seem to imply. That is, there are going to be other sorts of situation in which imitation activity is appropriate but the underlying motivations are going to differ. For example, play situations are going to have importantly different motivations than are problem-solving situations. Communicative learning situations are going to impose their own contrasting motivations with respect to learning and with respect to communication. What children understand about the *type* of situation(s) (and how that understanding is cognitively organized), the *type* of object(s) being interacted with, and the *type* of action(s) being demonstrated are all going to influence the *type* of imitation that takes place and there will be relevant cognitive and motivational aspects for all of them.

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[51] As a consequence of learning when imitation is appropriate (for learning, for play, etc.), children also learn when it is inappropriate and how that can be used as means to annoy, especially an older sibling.

CHAPTER 4: THE CURRENT STUDY

By Age 3, children will have learned much about different types of situations and they will be well-practiced imitators at varying levels of abstraction; therefore, the current study will not be trying to establish whether imitation activity of a certain sort is possible or not, but rather how what gets imitated depends on the child's motivation as well as on their understanding of the situation as manifest by presumptions of relevance. Presumptions about the situation in general (based on prior knowledge and experience) also form the basis for critically evaluating the argument that children in active action paradigms display mindreading abilities.

One of the major motivations for using active action paradigms[52] has been the assumption that it is a more sensitive and appropriate measure of what young children know about other people's minds than the linguistically complicated narratives of standard false belief tasks on the one hand and the methodological and conceptual limitations of looking paradigms on the other. Accordingly, the current study will use the same interactivist modeling resources used in the above analysis of imitation research to empirically investigate the use of an active helping paradigm that purportedly demonstrated false-belief understanding in 2.5- and 1.5-year-olds.

To clarify, for the classic framework, mentalism is inextricably linked to "true" imitation such that some degree of mindreading is necessary for genuine imitation activity. More specifically, the contents of mindreading are constitutive of what it means to understand an interpersonal situation and imitation activity proceeds on the basis of this understanding. From the interactivist perspective, imitation activity is grounded in

an understanding of the situation that is based on mutually shared anticipations about interactive potentialities rather than the attribution of mental states. Consequently, any attempt to render the child's understanding of imitation situations strictly in terms of anticipation is simultaneously a rejection of the mentalism framework.

As part of the general break from Piagetian theory in the late 70s and early 80s, developmental researchers studying imitation were primarily concerned with establishing the presence of imitation activity earlier than had been previously assumed. Consequently, the focus was on demonstrating a high fidelity behavioral match between model and infant and not on trying to determine what the infant understood about the situation. With the general acceptance that even neonates were capable of imitation, its investigation became decidedly cognitive but with only slightly more nuance in that the match between infant and model was suppose to include something about the mentality of the model. That is, 'true' imitation was suppose to require the infant to understand the intention/goal of the model and to selectively match their behavior on the basis of that understanding rather than on a literal match of their behavior. Procedures involving failed-attempts (Carpenter, Akhtar, & Tomasello, 1998; Meltzoff, 1995) were intended to differentiate between what was "actually" demonstrated and what the model intended to demonstrate.

With the general acceptance that infants imitated on the basis of the models intentions/goals, its investigation became further nuanced in that researchers began exploring the complexity of the infant's understanding of the imitation situation beyond just the intentions/goals of the model. This complexity included various situational

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[52] For a well known example, consider the re-enactment procedure used by Meltzoff

constraints (Gergely, et al., 2002; Nielsen, 2006), the infant's prior knowledge about affordances in the world (Huang, et al., 2002; 2006; Thompson & Russell, 2004), their prior and current knowledge about the competence of the model (Diyanni & Kelemen, 2008; Schulz, et al., 2008), their level of difficulty on the task (Harnick, 1978; Sibulkin & Uzgiris, 1978; Williamson, et al., 2008), and so on. Finally, as impressive as the demonstrations of young children's ability to selectively imitate has been (Brugger, et al., 2007; Carpenter, et al., 1998; Gergely, et al., 2002; Meltzoff, 1995; Schwier, et al., 2005; Southgate, et al., 2009; Williamson & Markman, 2006), older children's seeming inability to avoid over-imitating transparent transformations on novel artifacts (Horner & Whiten, 2005; Lyons, et al., 2007; McGuigan, et al., 2007) is equally profound.

Therefore, one purpose of the current project is to further contribute to our appreciation of the complexity involved in young children's understanding of imitation situations while directly challenging the claim that such interpretations ever includes explicit knowledge about the mental states of other people before the age of 3.5 – 4 years. That is, despite arguing for greater complexity, nuance, and flexibility with respect to children's understanding of imitation situations, the additional claim is that genuine "mindreading" abilities are not even potentially available to play a role in such understanding until 3.5 – 4 years of age. The reason for this claim derives from the nature of interactive knowing and the representational requirements necessary for reasoning about the perceptually inaccessible mental states of other people.

Knowing Levels: Reflecting on What is Interactively Known

(1995).

From the interactivist perspective, knowing *is* competent interaction and knowledge *is* the ability to engage the world successfully for some purpose (Campbell & Bickhard, 1986). However, knowing about the mental states of other people poses a general problem in that the organism has nothing to directly interact with. Minds (as well as hidden causes, essences, grammar, necessities, etc.) are not available for direct interaction and so explicitly representing these properties is not possible for an organism that is only able to interact with the external environment (the "thought only in (inter)action" constraint). Note, that even for object representation, the knowledge of the organism is in terms of the interactive potentialities and not in terms of the object per se. The *aboutness* of any such object representation is in terms of the implicit presuppositions that the environment (object) is appropriate to the indicated interaction as a potentiality, but that implicit presupposition is not itself explicitly known – explicitly represented. As a consequence, before the age of 3.5-4 children are not able to reason explicitly about object properties and this includes their relationship to other objects.

However, if a second level knowing system is able to interact with (reflect on) the first level system in a way that is similar to how the first level system interacts with the environment, then those implicit properties of the first level system can become known. That is, a second level knowing system could explicitly represent properties that are only implicit in the functioning of the first level system. The interactivist model actually proposes a hierarchy of knowing levels (Campbell & Bickhard, 1986) in which each higher level interacts with (represents) properties implicit in the level below it. This forces a strict sequencing of developmental "stages" in which no higher level of organization can be constructed prior to the development of some organization at the

level below it (level n cannot be constructed prior to the presence of level n-1) because a level of knowing with nothing immediately below it would have nothing to interact with (Bickhard, 1978).

Because the transitions between knowing levels will tend to be functional, they can occur differentially across domains and therefore will constitute a generally age *asynchronous* stage model of development; however, the initial transition from level 1 to level 2 requires an architectural change – brain maturation (Bickhard, 1992a). As a consequence, the initial transition from level 1 to level 2 will involve a generally age *synchronous* transition with respect to the new potentialities enabled by the second level system. The major emergence constitutive of the second level is the "initial ability for genuine epistemic reflection, and should make possible the development of many specific forms and instances and consequences of such reflection" (Bickhard, 1992a). Chief among these consequences is the general ability to think internally, to transcend the "thought only in (inter)action" constraint of first level knowing. More specifically, the possibility of internal thought enables abilities such as rehearsal, planning, transformational imagery, and the explicit consideration of hidden causes and relations – for both objects and agents (Campbell & Bickhard, 1986).

The implication of level-two reflection for mindreading abilities is fairly straight-forward: perceptually inaccessible mental states cannot be interacted with directly and therefore level-two reflection is required for any task that necessarily involves reasoning about those states. Because the capacity for reflection appears to develop around age 3.5-4, children prior to this age should not be able to engage in explicit mindreading activities. Less straight forward is the sense in which reflection applies to reasoning that

involves objects. Pre-reflective object knowledge is constituted by a web of interactive potentialities that remain invariant under some other class of further transformations; however, this organization is not itself known. That is, while the system is able to act in accordance with the presupposed properties of the organization that constitutes the invariance of objects, it cannot reason explicitly in terms of those presupposed properties. Therefore, it should (in principle) be possible to devise a task involving object knowledge that can differentiate between the implicitly presupposed (interactive) knowledge of object properties and knowledge that is explicitly represented.

The Diagnostic Power of Previous Experiments

Section 1 of the theoretical analysis of the literature argued for the conceptual and methodological inadequacy of research that purportedly demonstrated rudimentary mindreading capabilities in infants and young children. The discussion in that section detailed some of the problems:

1.) Deriving from the equivocation of terms (e.g., the use of goal as mental state and goal as outcome or goal as mental state and intention in action).

2.) Deriving from the implicit assumption about an ontological split between meaningless behavior and meaningful action (and the corollary assumption that the meaning of a situation was (or even could be) determined by an agent's intention (or a mental state of any kind)).

3.) Deriving from the taken-for-granted-assumption that the only way to understand behavior as intentional is through the attribution of mentality.

4.) Deriving from inadequately constrained empirical results such that an empirical outcome and its negation could both be interpreted as support for the same position.

Consequently, the above difficulties mean that the wealth of empirical imitation research on mentalism is diagnostically insufficient. That is, it does not differentiate between viable alternative interpretations about what might be the case regarding child development.

At the extreme, mentalist research has selectively examined those conditions that support the proposed hypotheses while ignoring other conditions that do not (Sirois & Jackson, 2007). This confirmatory approach to research, in which empirical results merely need to be consistent with the proposed hypotheses, makes for a problematic philosophy of science (Bickhard, 1992b). Part of the excitement from the original false beliefs tasks were that they seemed to provide the necessary diagnostic power to differentiate between reasoning that required explicit consideration of another person's mental states versus reasoning on the basis of some other, less sophisticated, set of cognitive processes. Recall that the original false belief task (Wimmer & Perner, 1983) was itself derived from some of the commentaries in response to a prior study (Premack & Woodruff, 1978) that was not diagnostically sufficient in exactly the sense that has been discussed throughout the current text. That is, much of the power of false belief tasks is that they seem to *necessarily* require the ability to reason about the internal belief states of another person.

Given the diagnostic power of the original false-belief tasks, the possibility of testing for such abilities in infancy would help to overcome the inherent limitations of

previous mentalism research. This would be the case in at least two senses. First, beliefs are "quarantined" from actions in a way that many of the other mental states are not (desires, intentions, goals, emotions, etc. all have "tell tale" signs, Meltzoff, 2007). Second, no one has proposed a plausible alternative strategy that would enable success on the standard false belief tasks without *necessarily* requiring the child to reason about the belief states of the agent (in some sense of reason). In a recent and provocative study, Onishi and Baillargeon (2005) have argued that (using a looking time procedure) they have demonstrated that 15-month-old infants understand that agents may act on the basis of their false beliefs.

However, there have been alternative, non-mindreading, interpretations (Perner & Ruffman, 2005; Ruffman & Perner, 2005; Sodian & Thoermer, 2008) and the authors acknowledge that these alternatives are not ruled out by their own empirical results (Onishi & Baillargeon, 2005). Further, it has been empirically demonstrated and conceptually argued that looking time procedures are fraught with problematic assumptions and systematically motivated interpretations (Allen, 2007; 2009; Allen & Bickhard, in-press; Bogartz, et al., 2000; Haith, 1998; Jackson & Sirois, 2009; Schilling, 2000; Schoner & Thelen, 2006; Sirois & Jackson, 2007). The gist of the methodological problem is that using looking paradigms to do studies while ignoring the dynamics involved in looking activity is like doing statistics without a null distribution; consequently, the result are, at best, inconclusive and, at worst, incoherent.

Using an Active Helping Paradigm to Establish False-Belief Understanding

As a consequence of the inherent limitations of looking time procedures, Buttelmann et al. (2009) investigated children's false-belief understanding using a more

active behavioral measure than looking – one that exploits young children's propensity to help others who are having difficulty attaining their goals/outcomes[53]. Similar to the sequencing involved in the original false-belief task (Wimmer & Perner, 1983), after an adult (E2) placed a toy into one of two boxes, children watched as the other experimenter (E1) moved the toy to the other box, either in the presence of E2 (true-belief condition – TB) or in their absence (false-belief – FB condition). During the test phase, E2 attempted to open the box that originally contained the toy. Unable to do so, the child was allowed/encouraged to help E2. In the true belief condition children would presumably understand that E2 wanted to open the box rather than retrieve the toy since they had witnessed the displacement of the toy into the other box. In the false-belief condition, if children understood E2's false belief, then they would help them by retrieving the toy from the other box.

The results from study 1 indicated that a majority of 2.5-year-olds (75%) in the true belief condition assisted the adult by opening the box that E2 had just tried to open, while a majority of children (83%) in the false belief condition retrieved the toy from the other box. These results suggest that children were able to correctly identify the desired goal/outcome of E2 in the test phase and did so by incorporating the relevance of whether the adult was present for the displacement of the toy (TB) or not (FB). Study 2 was a replication of the first study using 18- and 16-month-olds. Results for the older group

[53] In that sense, it can be understood as a more complex version of Meltzoff's failed-attempt paradigm (1995) because it also requires incorporating an agent's false-beliefs into an understanding of what the adult is trying to do – the major difference between the two being the type of situation involved (helping versus imitation). Further, unlike the 3.5-year-olds tested with Meltzoff's paradigm (Huang, et al., 2006), these 2.5-year-old children do not replicate E2's "literal" actions but rather they help E2 accordingly. This

mirrored those of the 2.5-year-olds while that of the younger group showed a similar pattern, but less clearly. These results were collectively interpreted as demonstrating that "by 18 months and possibly by 16 months of age infants clearly make use of their understanding of others' false beliefs to help them appropriately" (pg. 341, Buttelmann, et al., 2009).

Importantly, the specific difference in the pattern of results from the 16-month-olds was with respect to the TB condition. In the FB condition they choose to retrieve the toy with equal frequency as the 18-month-olds and the 2.5-year-olds – it was in the TB condition that the 16-month-olds were at chance. This pattern of results is counter-intuitive because implies that true-belief understanding improves between 16- and 18-months while false-belief understanding is equally present at all ages. Therefore, assuming that FB understanding *does not* develop prior to TB understanding, these results suggest that infants of this age must be preferentially retrieving the toy in the FB condition for reasons that are independent of reasoning about beliefs altogether. The obvious suggestion is that the toy is relatively salient and what requires explanation is why this tendency is reduced in the TB condition.

Methodological limitations.

Before discussing the logic of the reasoning requirements for success on the above task, consider two inter-related methodological limitations of the study: specifically, the potential relevance of "playing a trick" and its relationship to the salience of the toy. In addition to the false-belief manipulation, the other (potentially relevant) difference between the two experimental groups is that in the FB condition, and prior to

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highlights the relevance of an imitation situation being understood as such for the results

the displacement of the toy, children are informed by E1 that "E2 was not present and therefore could not see, and invited the child to 'play a trick' on E2"; whereas, in the TB condition children are informed that "E2 was present and therefore could see, and invited the child join her" as she moved the toy to the other box.

It is not at all clear a priori what an understanding of tricks involves, but results from the Buttelmann study also indicated that children in the FB condition were preferentially motivated to share the location of the toy even before E2 had attempted to open the original box. That is, after re-entering the room and "as (or even before)" E2 attempted to open the original box, seven (or about 30%) of the 2.5-year-olds attempted to inform E2 that the toy had been moved (in contrast, only 1 child did so in the TB condition). At this point in the procedure E2 had not tried (unsuccessfully) to open the original box and so something about the situation (up to this point) motivated children to "help" E2 by retrieving the toy. There are two salient possibilities for what that something is: either the mere absence of E2 while the toy was moved or else the fact that the child is playing a trick (or their interaction).

The authors do not consider the potential relevance of the trick manipulation and they interpret the mere absence of E2 as corroboration for their interpretation that children are acting on the basis of E2's false belief. However, that children preemptively informed E2 of the toy's new location presupposes that they expected E2 to retrieve the toy upon entering the room. This is important because it was suppose to be the failed-attempt to open the original box that induced the crucial false-belief-requiring inference that they must be trying to retrieve the toy. The current suggestion is that prior to the

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that are subsequently obtained in empirical research.

failed-attempt to open the box (and therefore prior to the impetus for the false-belief-requiring inference), there were at least three factors motivating the child to retrieve the toy: first, the toy itself has a certain salience; second, at least some children had a general expectation that the adult would be searching for the toy; third, and related to the second, the deceit involved in playing a sort of hide-and-seek trick would highlight the hidden toy further, in addition to its inherent salience.

The broader point regarding the "trick" manipulation is that children have extensive prior learning experiences with themselves and with adults in all sorts of different types of situations involving routines, games, various types of coordination and play. Consequently, whenever the conclusions of a study are concerned with what is cognitively required (or what cognitive abilities children *must* possess) for the completion of some task, recognition of these shared practices[54] is essential. In particular, if it is the child's previously learned experiences with playing hide-and-seek type tricks on others that enables them to "succeed" on the task, then the task is answering a different question than the one asked about false belief understanding. The relevance of previous learning for conclusions about what success on a given task indicates is exemplified by the historical attempts to demonstrate that various competencies measured by Piagetian task were present earlier than Piaget had suggested. For example, Bryant and Trabasso (1971) purportedly demonstrated an understanding of transitive inference in young children, but their procedure included extensive training such that a plausible alternative interpretation was that they had learned to succeed on the "transitive inference" task without actually using transitive inference abilities. While the current procedure does not involve

extensive training, it does draws on children's extensive prior experience with boxes, playing with adults and toys, and what it means to play a trick. Povinelli and Vonk (2003) make what is essentially the same point with respect to the comparative literature when they point out that ecological settings are the least diagnostic precisely because they exploit previous learning (either ontogenetically or phylogenetically).

From the interactivist perspective, the more general point is that the level 1 knowing systems can always learn to perform any general procedure with sufficient training or experience. Therefore, novelty is a crucial aspect of demonstrating the presence of level 2 reflection. In particular, the type of novelty that is present for atypical situations that involve counterfactual reasoning. If level 2 reflection enables the ability to think internally, then the consideration of unexplored spaces of possibility can proceed without having to physically engage in that exploration (something that *is not* the case for level 1 knowing given the "thought only in action" constraint). A major theme running through out the current paper has been to argue that researchers have (until recently) mostly neglected the rich quotidian structuring of experimental situations and in so doing have been ignoring the potential relevance of the child's current and prior history of shared practices with other social agents in a variety of situations.

Conceptual limitations.

Having discussed some potential methodological limitations (i.e., "trick" manipulation and toy salience) of the above study and briefly considered some more general concerns regarding previously learned patterns of social activity, let us return to discussing the logic of the reasoning requirements for success on the helping task.

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[54] This phrase has been lifted from Racine and Carpendale (2007) to indicate the mutually

Buttelmann et al. argue that, while the helping paradigm did not require *predicting* the adult's behavior (as is the case for the classic tests), it does require children to:

> imagine what the goal of this behavior was – in the sense of the adult's mental representation of the state of the world he desired – and they had to do so differently in the different conditions based on his beliefs about the current state of the world (i.e., whether or not he believed the toy was in the box, p. 341).

It is not unexpected that these authors subscribe to a fully mentalist rendering of how children interpret the "goal"-directed behavior of others given their broader theoretical framework (Tomasello, et al., 2005). Accordingly, their concern in this study is to determine whether, in addition to representing the (mental) goals and desires of others, children at these ages are also able to represent false-beliefs (and thus beliefs in general). However, the author's presumption of mentalism (at the level of goals and desires) contaminates their analysis of an alternative non-false-belief interpretation. Specifically, the authors acknowledge that they need to rule out the possibility that success on their task could be the result of children's understanding of *knowledge versus ignorance* (rather than false-belief). They go on to dismiss the possibility that children in the FB condition attribute to the adult a blank thought bubble (representing ignorance) because then they would have no reason to retrieve the toy when the adult attempted to open the original box.

However, there are an infinite number of possible beliefs that a person is ignorant about and so why do the authors consider that an ignorance-interpretation requires that children would have no reason to retrieve the toy. Doesn't the adult also have no reason

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held understanding of a situation based on previous learning.

to jump up and down and wave goodbye and so on? The point is that an ignorant E2 would still be expected to do certain things with much greater probability than others. Children's reason for retrieving the toy could be the same reason that any of the infinite number of beliefs that we do not hold ever become explicit in an actual situation: through a presumption of relevance. In trying to understand the behavior of an ignorant (but agentive) E2, it would be reasonable to presume that in spite of his ignorance, the toy is relevant precisely because E2 was trying to open the box (i.e., people typically open boxes to retrieve or store items) despite not knowing where the toy was located. Contrary to the child having "no reason to retrieve the toy" it is precisely the toy that could make good sense out of what an agentive (even if ignorant) E2 might possibly be doing.

However, the authors excluded the potential relevance[55] of the toy in this situation because of their results from the TB condition. The authors claim that, in the TB condition everything is "exactly" the same[56] (except for the continuous presence of E2) and children helped the adult by preferentially opening the original, empty, box. In other words, if the toy was relevant in the FB belief condition then why not in the TB condition? However, one of the major differences in the TB conditions is that the toy is not really available as a possibility to make sense of what E2 is doing when they try to open the original box (unless perhaps the toy is always in that box and the adult has a bad short term memory and so on). Much like children who will imitate the means of an action when there is no apparent goal (Carpenter, et al., 2005), children may be

[55] They do not actually discuss relevance but rather salience. However, this difference is important because relevance always has context and historistic dependencies that are with respect to the specific situation/agents, whereas salience is typically construed as an inherent property of the object with respect to general interest.

compelled to help the adult in the only way that they are able given the situation. No appeal to the beliefs states of E2 is required for the child to know that an implication of the adult having seen the toy moved is that they can retrieve the toy at a later time. Given that knowledge, the child (and presumably anyone) may be uncertain about *why* the adult is trying to open the empty box and so children help in the only way that makes any sense (by opening the empty box) and await the ultimate purpose.

Finally, a more general problem with the author's consideration of the *knowledge versus ignorance* alternative interpretation is that it already presupposes that children are explicitly representing various mental states of the adult. The only distinction ostensibly under consideration is the one between generating by an explicit representation of ignorance and an explicit representation of a belief that is incorrect. But this defeats the purpose of caring so much about false-belief understanding in the first place. Part of the original focus on false beliefs was a consequence of attempting to empirically differentiate at what age children could succeed on a task that *required* attributing a false belief and thus definitely demonstrate that they were able to attribute beliefs and other mental states in general. Therefore, the current claims are not only that the child could be expected to retrieve the toy in (what happens to be known by us as) a case of ignorance; but also, that the child could incorporate E2's absence without explicitly attributing any mental states at all – let alone a false belief.

Consistent with Perner and Ruffman (2005), who suggest that infants may use a triple association between agent, object, and box location to interpret subsequent reaching behavior, children in the helping paradigm may be making use of the fact that E2 was not

[56] The discussion above regarding the "trick" manipulation illustrates how this claim is

present during the displacement of the toy in terms of the *anticipations* that are induced by E2's most recent prior interactions with the toy and the box rather than in terms of E2's false-belief. Over the course of the second year infants learn about the *relevance* of an agent's visual access to events with respect to their subsequent "search" behavior (Moll & Tomasello, 2004; Sodian & Thoermer, 2008). However, the interactivist perspective does not require a belief-desire rendering of "relevance", and "search" is understood more broadly in terms interactive potentialities. Therefore, development throughout the second year can be understood to involve learning about the interactive potentialities that follow from an agent's prior interactions (including visual access). If these prior interactions involve an agent placing a toy inside a box, then the child can construct a specific anticipation *about* the adult – that they could subsequently open the box and retrieve the toy[57]. Further, this previously constructed anticipation about the potentialities of the specific agent could later be used as a resource for trying to interpret the agent's subsequent behavior. The differential behavior of children in the TB condition is explained by the fact that the previously generated anticipation about the adult can be updated by relevant circumstances in subsequent situations. In this case, the relevant circumstances concern visual access.

In sum, there are at least two possible alternative interpretations regarding children's performance in the study by Buttelmann et al., neither of which require the attribution of any mental states to the agent. First, the *ignorance* alternative need not involve a representation of ignorance but rather could draw entirely on the circumstances

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false and that its potential significance was not controlled.

of the current situation to generate an assumption about the purpose of the agent's actions. Second, the *anticipatory* interpretation[58] involves an alternative account of representation and knowing that models learning and development as the progressive differentiation of relevant circumstances for future interactive potentialities. This progressive differentiation applies to agents as much as it applies to objects and so the past experience of the agent could provide an additional resource for the child in their attempt to generate an assumption about the purpose of the situation given the current circumstances.

"How" Do Children Help in the Helping Paradigm: Getting Back to Imitation

While the empirical results from the above helping procedure are consistent with children acting on the basis of E2's false belief, they do not rule out non-mentalistic possibilities. The helping paradigm turns on what children understand about the situation with respect to helping the adult. This produces an interesting situation because *how* children help is going to depend on both: 1.) their interpretation of what the adult is attempting to accomplish; and also, 2.) their knowledge about the world. Regarding the latter, even an adult is going to be of little help if they do not already have the requisite knowledge for how to be of assistance (e.g., helping a stranded driver jump start their car involves knowing how to use jumper cables). In the study by Buttelmann et al. (2009), children are given the requisite knowledge for how to open the boxes in the

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[57] This is analogous to a child constructing a specific anticipation about a ball that it can bounce; and just as with agents, they may learn later that this anticipation only holds under relevant circumstances (i.e., as long as it is not too cold, etc.).

[58] This interpretation is actually an elaboration of the ignorance interpretation that also incorporates the relevance of the absence of E2.

demonstration phase prior to the experimental manipulations. That is, children learned that pulling the pin (a sort of lock) on the front of the box was relevant for opening it.

The second crucial aspect influencing *how* children go about helping an adult concerns their understanding of what the adult is attempting to accomplish. That is, children in the helping paradigm have to make an assumption about what the adult is doing in order to assist them. The specific procedure used by Buttelmann et al. implicitly constrains the possible interpretations involved: either E2 is trying to open the box to retrieve the toy or else E2 is trying to open the box for some other purpose. In other words, there are only two salient possibilities for how to help E2 and the toy is probably the default assumption (either because people typically open containers to retrieve or store goods – ignorance interpretation – or because the most recently updated anticipation about E2 involves them retrieving the toy – anticipatory interpretation). The preference of children in the TB condition to open the box without the toy can then be understood as a consequence of them ruling out the toy as E2's goal[59] given that E2 saw the displacement of the toy into the other box. By contrast, children in the FB condition do not have this additional source of constraint (i.e., certainty about what E2 *does not* want) and so the toy may simply remain the default assumption regarding what E2 is attempting accomplish by trying to open the box. Finally, during the test phase when children are allowed/encourage to help the adult, opening of the box becomes decidedly instrumental towards the broader "pro-social" motivation to help. Consequently, this provides a perfect opportunity to investigate how motivation, uncertainty, and relevance contribute

[59] It should be clear that the term "goal" is being used here in the non-mentalistic sense of goal-as-outcome.

to and influence what aspects of a demonstrated sequence get reproduced during different types of situations.

Research Questions and Hypotheses

The general helping paradigm of Buttelmann et al. (2009) is well suited to independently investigate the two major loci of previous imitation research: imitation as a phenomenon and imitation as a methodology for theoretical claims about mentalism.

Research Question1: Imitation.

What are the implications of characterizing imitation activity as a strategy for using adults as a resource for information that is a consequence of both the cognitive and motivational aspects involved in resolving uncertainty in different types of situations? Specifically, in problem-solving situations, will children imitate primarily on the basis of what they understand to be relevant? If these situations are particularly novel or difficult (general uncertainty) or result in failure (outcome oriented uncertainty), then will their relevancy judgments be more open to realignment in terms of higher fidelity imitation? In play (or helping) situations, will children's motivations differ such that they tend to imitate on the basis of what they anticipate to be fun (or helpful)?

Cognitive Aspects:

Hypothesis 1a. Over-imitation will increase with age such that three-year-olds will imitate irrelevant actions the least, followed by four-year-olds, with five-year-olds imitating irrelevant actions the most.

Prediction 1a. Children will imitate removal of the pin and opening of the drawer most often followed by rotation of the lever. Children will push the button and tap the top of the box with the pin least often.

Hypothesis 1b. Children's presumptions about which actions were relevant for opening the box will be updated after encountering interactive failure such that they will copy the model with greater fidelity.

Prediction 1b. After being unable to open the box, children will revise their attempt so as to include steps that they had previously left out.

Motivational Aspects:

Hypothesis 1c. The child's presumptions of relevance regarding what to imitate will differ depending on the construal of the imitation situation (play vs. problem-solving) such that irrelevant actions will be imitated more in the play condition.

Prediction 1c. Children in the play condition will imitate pushing of the punch-button, rotation of the lever, and tapping of the pin more than those in the problem-solving condition. Children in the play condition will also show less matching (i.e., score lower) in their *sequencing* of the various actions than those in the problem-solving condition.

Hypothesis 1d. Children's presumptions of relevance regarding what to imitate will differ depending on the type of situation (imitation or helping) such that irrelevant actions will be imitated more in the imitation situation.

Prediction 1d. Children in the imitation situation will imitate pushing of the punch-button, rotation of the lever, and tapping of the pin more than when they are in the helping situation.

Research Question 2: Mentalism.

Does success on Buttelman et al.'s active helping paradigm demonstrate that children are acting on the basis of the adult's false-belief. Further, does young children's

ability to make assumptions regarding what an adult is trying to accomplish depend on their familiarity with the objects involved and their understanding of the broader scenario?

Hypothesis 2a. In the absence of a well-defined purpose for an adult's attempted actions, children will make the default assumption that recovering a salient toy will be an appropriate way to help.

Prediction 2a. Children in the *clairvoyance* condition will preferentially help the adult by retrieving the toy rather than opening the (now) empty box.

Hypothesis 2b. Children's familiarity with the function of boxes and their understanding of broader scenarios is sufficient to correctly presume the goal of an adult agent's actions for the purpose of providing assistance to them.

Prediction 2b. Children in the hands-full condition will use their understanding of hiding toys to interpret the adult's attempt to find an empty container and will help the adult preferentially by opening the (now) empty box.

Research Question 3: Reflection.

Finally, the helping paradigm is fundamentally about action interpretation in an unfolding current situation rather than action prediction in a counterfactual future. As such, the paradigm is only *potentially* adequate to show that reasoning in terms of beliefs states is not *necessary* to "correctly" help the adult. That is, the paradigm does not allow for the creation of conditions that would necessarily *require* reasoning in terms of belief states in order to succeed. Therefore, the stronger claim that reasoning in terms of belief states is not possible until around 3.5-4-years of age requires a more circuitous route.

From the interactivist perspective, there is a fundamental continuity between being able to reason in terms of object properties and being able to reason in terms of an agent's mental states – both require reflection. While the idea that children under 3.5-4 cannot reason about mental states is considered by current research as unlikely, the possibility that they cannot reason about objects per se is inconceivable. Therefore, if it can be demonstrated that thinking about objects requires reflection, then that would strengthen the interactivist claim that genuine mindreading also requires reflection (something that is not available until age 3.5-4).

Does children's ability to reason in terms of the mental states of another person require internal reflection and is this capacity available prior to age 3.5-4?

Hypothesis 3a. Without the capacity for internal reflection, children will not be able to reason explicitly about object properties/relations and therefore about the consequences for objects in a novel situation.

Prediction 3a. Children younger than 3.5-4 will fail to understand that two objects leaning against each other will be mutually supportive.

Hypothesis 3b. Without the capacity for internal reflection, children will be unable to reason explicitly about the mental states of fictional characters and therefore how those mental states might contribute to possible predictions about their future actions.

Prediction 3b. Children younger than 3.5-4 will fail to understand that characters will look for desired objects in places that are consistent with their false beliefs rather than reality.

Hypothesis 3c. The requirement of internal reflection for explicit reasoning about perceptually hidden properties is a domain general constraint; therefore, tasks across domains should be related.

Prediction 3c. As a simpler manifestation of internal reflection, children's scores on the leaning blocks tasks should predict their performance on the false-belief task such that they do not tend to do well on the latter without also doing well on the former.

Methods

Participants

Seventy-four middle-class children (aged 3-5, 27 female, 47 male) were recruited through the mail and a local daycare. Half of the children were assigned to one of two imitation conditions. The same 74 children were then assigned to one of three mentalism conditions. Finally, all 74 children completed a novel object reasoning task and three theory of mind tasks.

Materials

Materials for the imitation part of the experiment included several stuffed animals, two punch buttons from staples, and two medium-size wooden boxes (one white and one dark brown). Each of the wooden boxes had a drawer with a knob to open it. The drawer gets "locked" by a pin in the top of the box with a non-functional rotating lever attached behind the pin that rotates 180 degrees. Finally, a screen cutout slides on top of the box to hide a surreptitious locking device on the side of the box. Materials for the leaning blocks task included several small blocks, two large blocks, and two large cardboard rectangles.

Design

Each child was given 6 tasks: set within the context of playing a new game, children were given an imitation box task (using either the play or the problem solving condition); followed by an opportunity to help an adult confederate open one of the boxes – the helping task (using either the false-belief, the clairvoyance, or the hands-full condition); after the boxes game was over, everyone was given the leaning blocks task (with 5 variants) and then three theory of mind tasks: unexpected contents, change of location, and active deception.

General Procedure

Some variations on the active helping paradigm used by Buttelmann et al. (2009) were used to test the first two sets of hypotheses concerning imitation and mentalism while the third set hypotheses used the three theory of mind tasks (unexpected contents, change of location, and active deception) and an original blocks task devised by Bickhard (1978) to test for the necessity of reflection for thinking about objects per se and by extension about mental-states as unseen causes of behavior.

The following is a general outline of the helping procedure: After a warm-up session with two experimenters (E1 & E2), the child was seated on a cushion that was equidistant (approximately 1 m) from the two boxes that were themselves about 1 m apart. The two punch-buttons were placed about 30 cm away from the inside edge of the boxes and the locking pin for each box was placed directly in front of them (approximately 10 cm). E1 was seated next to the child while E2 was seated between the two boxes facing the child and E1. After exploring the boxes (by opening and closing each of them twice), E2 left the room in search of their favorite toy and E1 demonstrated to the child that the boxes can be opened using a specific sequence involving the punch-

button, the lever, the pin, tapping the pin and pulling on the knob. However, the only necessary steps in this sequence involved the removal of the pin, and pulling of the knob. E1 ensured that the child had successfully opened the drawer twice for each box (after having been reset by E1) before continuing with the experiment. It was during this *demonstration* phase that the first imitation manipulation took place. It is subsequent to this phase that any of the mentalism manipulations occured and that opening the box in order to help the adult became decidedly instrumental for the child (i.e., the second imitation manipulation).

Imitation Box Task.

For all participants, after E2 had left the room to retrieve their favorite toy, E1 demonstrated to the child how to open the two boxes. There were five progressively more plausible steps involved in opening either box. Step 1: unnecessary-off-object manipulation – the punch-button was pressed once. Step 2: unnecessary-on-object manipulation1 – the lever on the top of the box was rotated from right to left 180°. Step 3: necessary-object manipulation1 – involved pulling the pin out of its hole. Step 4: unnecessary-on-object manipulation2 – tapping the pin on the edge of the box three times. Step 5: necessary-object manipulation2 – pulling on the knob in order to open the drawer. The experimenter did not provide any corresponding vocalizations during the *demonstration* phase unless the child lost focus, in which case the experimenter would stop and use verbal prompts (e.g., "[participants name], can you see what I am doing?", "[participants name], can you watch me?") to regain the child's attention.

Two conditions were used to explore how motivation, uncertainty, and assumptions about current relevance modulate what aspects of a demonstrated sequence

are selectively reproduced. Because the general form of the helping paradigm is such that there are two distinct phases, investigation of the imitation aspects and the mentalism aspects can take place independently of each other. As a consequence, the imitation conditions do not need to be crossed with the mentalism conditions. Further, because the general procedure involves an imitation situation that is ultimately instrumental for the broader helping/problem-solving situation (i.e., there is a shift from imitation to helping) this procedure provides the perfect context for looking at how imitation activity might change across situations.

***Play condition*:** Previous research has demonstrated that how a task is verbally introduced can alter the degree of fidelity between model and child during imitation. Specifically, there was higher fidelity imitation when the model used a label that could be interpreted by a previously acquired script (i.e., event sequence and end-state). For example, when the model said: "Look, I'm planting a flower" there was higher fidelity imitation than when the model used a more general label: "Look, I'll show you something". From the interactivist perspective, the verbal introduction provides the level of differentiation that is relevant for the child to learn what the model has intended. In the current study, the play condition is intended to extend the potential impact that the verbal framing of the situation can have on imitation activity in terms of providing the relevant contextualization. Thus, after E2 left the room to retrieve their favorite toy, E1 introduced the activity as an opportunity to learn how to play with the boxes. Specifically, E1 said: "Let me show you how to play with the boxes".

***Problem-solving condition*:** In contrast to the play condition, after E2 left the room to retrieve their favorite toy, E1 introduced the imitation activity as an opportunity

to learn how to open the boxes. Specifically, E1 said: "Let me show you how to open the boxes". Additional procedures related to the imitation aspect of the study remained constant across the two conditions.

Helping Task.

Regarding the mentalism aspect of the study, three different conditions were used to test the possibility that children's correct assumptions about what the adult is trying to accomplish in Buttelmann et al. (2009) study is a consequence of their ability to interpret the current situation in terms of the salient possibilities (i.e., the two boxes and the toy) and anticipations based on their prior understanding of different types of situations, independently of any false-belief reasoning.

***False-belief condition*:** This condition was a replication of Buttelmann et aleagues. After the imitation phase, E2 returned to the room with their favorite toy and excitedly engaged the child in play. After 90 seconds of joint play, E2 announced that they were going to put the toy away and returned to the starting position between the two container boxes facing the child and E1. E2 then looked at both boxes and placed the toy in the second one (this was counter balanced) stating: "I'll put it in here". Next, E2 realized that they forgot to clean up a mess and left the room again closing the door behind themselves. At this point, the "false-belief" manipulation began. While E2 was absent, E1 pointed out to the child that E2 was gone and could not see them. Next E1 invited the child to "play a trick" on E2 by moving the toy in a "sneaky way" to the other box ensuring that both boxes were now reset (locked). After the toy had been moved and both boxes had been locked, E1 gestured "shh" to the child who was explicitly instructed not to tell E2 about the switch when they returned to the room. Finally, E1 and the child

returned to the cushion and E2 re-entered the room. At this point, the *testing/helping* phase began. E2 entered the room and stood centered between the two boxes, looked at each very briefly, and said: "So". Having looked at the (now) empty box last, E2 approached that box, knelt down and attempted to open the drawer using the knob. After a brief pause, E2 said: "Hmm" and then, unable to open the box, returned to a position centered between the two boxes showing signs of "disappointment", "puzzlement", and "resignation". E2 then slowly alternated their gaze between a spot on the floor in front of them and the child's face, being sure not to look at either of the two boxes. Finally, the response period began in which the child was allowed to approach the boxes and help E2. If the child hesitated, E1 systematically prompted the child as needed: after 10s, E1 said "Go on, you can help her/him" with a follow up of the same prompt after another 5s. After an additional 5s, E2 asked the child if they could help them: "can you help me", with E1 offering to "go together" 5s after that. Finally, after an additional 5s, E2 asked the child to "can you open one of the boxes please". The task concluded with the child being asked what they thought E2 wanted and why they opened a given box.

***Clairvoyance condition*:** This condition was identical to the FB condition except that, after E2 had returned from cleaning up their mess in the other room, they tried to open the box with the toy in it, instead of the (now) empty box that had previously contained the toy. If children were reasoning in terms of the adult's false belief to figure out what they wanted, then they would have to assume that the adult did *not* want the toy, though without having any real good idea of what they were after. The logic of this condition is identical to that of the TB condition in the original study except that it turns on a false-belief rather than a true-belief and, in so doing, is able to tease apart

mindreading and non-mindreading interpretations. That is, in both cases the child should have a confident evaluation of what the adult does *not* want (the toy – assuming they can think about beliefs and false-beliefs at all).

***Hands-full condition*:** This condition was identical to the FB condition with three exceptions: 1.) E1 provides the toys to play with: In the FB condition, E2 returned after their first departure with their favorite toy. In the HF condition, E1 provided the toys and played with child while E2 was still absent. 2.) A hiding scenario was used instead of playing a trick: When E2 did return to the room he told E1 and the child that he had seen Oscar the Grouch out in the hall taking all of the toys laying around and putting them in his garbage can. E2 then suggested that E1 and the child hide their toys as well and placed them in one of the boxes. E2 then left the room to go hide some other toys that they had forgotten to put away. 3.) E2 returns with their hands full: upon returning, E2 had their hands-full of new toys and (as in the clairvoyance condition) they tried to open the (now) full box instead of the (now) empty box that had previously contained the original toys.

Leaning Blocks Task.

For the internal reflection part of the study, an original task was created. Specifically, an object *manipulation* task was used to test for the necessity of reflection for reasoning explicitly in terms of object properties and relations (Bickhard, 1978). The first major difficulty for devising a test of reflection is that a level 1 knowing system can *learn* any particular interactive procedure with enough practice or training. Consequently, the task must involve sufficient novelty such that children can not respond correctly on the basis of prior interactive learning and knowledge. The second difficulty

concerns finding a task that is capable of teasing apart the reflective aspects of the task (explicit representation of objects) from the interactive knowing aspects (implicit presupposition with respect to objects) such that the former are *necessary* for success.

The leaning blocks task involved a *demonstration* using small wooden blocks. The experimenter placed a block on edge (holding it at the top) and asked the child: "what will the block do if I let go?". After the block had fallen, it was removed and the experimenter placed a second wooden block (opposite the location of the first one) on edge and asked the child: "what will the block do if I let go?". Finally, the experimenter leaned the two wooden blocks against each other (holding them near the top) and asked the child: "what will the blocks do if I let go?". Those children incapable of reflection were expected to assume that the blocks would fall because they were unable to reason explicitly about the relationship between them and therefore could not anticipate the consequences of what would happened given the new situation.

Different sizes and configurations of blocks were used to produce five separate variants of the basic procedure. Three of these were perceptual variants while the other two were structural variants. All of them involved the same set of questions and feedback. Regarding the three *perceptual* variants, big rectangular blocks, small rectangular blocks, and big cardboard rectangles were used. For the first *structural* variant, two small blocks were held side by side such that one of them was also leaning against a third medium size block but the other one was only being supported by the experimenter's hand. Finally, the second structural variant was the same as the first except that the two small blocks were glued together and children were given a chance to see that they did not separate.

Theory of Mind Tasks.

Three separate TOM tasks were used to test children's explicit false-belief understanding. First, children were tested on an unexpected contents task (Perner, Leekam, & Wimmer, 1987) using a crayon box with a plastic horse inside. The task involved two control questions, one target question, and a justification question. The experimenter began by asking the child "What is in the box?". After answering that there were crayons in the box, the experimenter asked the child to open the box and empty its contents. After discovering its contents, the experimenter and child put the toy horse back inside and closed the lid. Children were then asked two control questions: 1.) "Before you opened the box, what did you first think was in it?", and, if they correctly answered crayons, they were asked 2.) "But what is really in the box?". This was followed by the target question: "Your friend [Tommy] has not seen this box yet, what will [Tommy] *think* is inside the box before he opens it?" followed by the justification question: "Why will [Tommy] say that?". Children received a score of 1 if they answered all of the questions correctly and a score of 0 otherwise.

Second, children were tested on a change of location task (Wimmer & Perner, 1983) using a 5-step picture story narrative. After the story was over, children were asked two control questions, one target question, and two follow up questions to justify their answer. The picture story was as follows:

Step 1: Is a picture of Johnny in the kitchen of his house receiving a piece of "delicious chocolate cake" from his mom.

Step 2: Shows Johnny placing the cake in the cupboard because he wants to go outside and play with his favorite ball.

Step 3: Shows Johnny outside playing with his favorite ball

Step 4: Is a picture of Johnny's mom placing the cake in the refrigerator so that the frosting doesn't melt.

Step 5: Is a picture of Johnny's mother waving goodbye as she drives to the store to buy something for dinner.

After the pictures had been presented, children were asked the two control questions: 1.) "Where did Johnny put the cake before he went outside to play?", and, if they answered correctly, 2.) "Where is the cake now?". Next, the experimenter asked the target question: "When Johnny come inside for some cake, where will Johnny look *first* for the cake?". Finally, children were asked to justify their answer: "Will he find the cake when he looks there?" and "Why/Why-not?". Children received a score of 1 if they answered all of the questions correctly and a score of 0 otherwise.

Third, children were tested on an active deception task (Chandler, Fritz, & Hala, 1989) involving two toy people who were playing a hide and seek game in a small sand box. Children were asked to select either "Mark" or "Sue" to be on their team. If, for example, Mark was selected, then Sue was placed behind the experimenter and the child was told that she could no longer hear or see us. The experimenter then demonstrated to the child how the game was played. Mark was used to hide a sticker under one (of three) cups laying at one end of the sand box. However, to hide the sticker, Mark had to walk in the sand leaving footprints behind. Children were asked if they knew what to call the "foot prints" that Mark left in the sand and were then told explicitly "That's right! You can see Mark's footprints. So Sue will know where Mark has been walking to hide the sticker. Hmm, we don't want that!". The sand box was then reset and children were

given their turn to hide the sticker just like the experimenter had shown them. After walking to one of the cups and hiding the sticker, children were asked: "Okay, now before Sue comes back, what can you do to make her look under the wrong cup?" If needed, children were prompted: "Can you do anything else to the sand or can you do something with Mark to make Sue look under the wrong cup?". Finally, just before bringing Sue back, children were reminded that: "In this game if Sue finds the sticker, then she wins, but if Sue looks under the wrong cup then you win". After Sue was brought back and said "hello" to Mark, children were asked the target question: "where should I look for the sticker". Children received a score of 1 for this question if they indicated a false location or if they claimed not to know. Whether their score increased depended on what they did when given a chance to cover up Mark's footprints. Specifically, children received a score of 2 if they erased the footprints that they had originally been made when hiding the sticker. They received a score of 3 if they made multiple sets of footprints. Finally, they received a maximum score of 4 if they erased the original set of footprints and made a false set to one of the empty cups.

Results and Discussion

Three main research question were investigated in the current study. First, how do cognitive and motivational aspects in different types of situations influence what children imitate? Second, does the active helping paradigm demonstrate false-belief reasoning? Finally, does mindreading require reflection? Results and discussion for these three questions are presented in sequence.

Research Question 1: Imitation

What are the implications of characterizing imitation activity as a strategy for using adults as a resource for information that is a consequence of both the cognitive and motivational aspects involved in resolving uncertainty in different types of situations? Specifically, in problem-solving situations, will children imitate primarily on the basis of what they understand to be relevant? If these situations are particularly novel or difficult (general uncertainty) or result in failure (outcome oriented uncertainty), then will their relevancy judgments be more open to realignment in terms of higher fidelity imitation? In play (or helping) situations, will children's motivations differ such that they tend to imitate on the basis of what they anticipate to be fun (or helpful)?

Coding.

Six children were excluded from coding and analyses (2 for being uncooperative and 4 for not wanting to take a turn opening the boxes). The purpose of the imitation coding was to establish a measure of how much children were imitating that could also be divided into the imitation of relevant and irrelevant action components. Most of the analyses were based on the first five actions that children performed on the boxes averaged across four training trials (2 for each box); however, this did not include

consecutive repeats (i.e., steps 1,1,2,3 would be coded as 1,2,3 but 1,2,1 would be coded as 1,2,1). Both the number of distinct target actions and the sequencing of those actions were coded to look for potential differences in overall imitation scores between the two. The target action (TA) score had a maximum of five (1 for each of the distinct target actions) and the sequencing (SQ) score had a maximum of 10. The sequencing score was established by counting all of the possible pair-wise comparisons (i.e., 1-2-3 has three pair-wise comparisons: 1-2, 1-3, 2-3). Finally, for one of the analyses, we coded the total number of times that children produced each of the five distinct target actions at any point throughout the imitation phase; again, consecutive repeats were not included.

Analysis.

A multivariate analysis of variance was conducted to assess whether there were differences in the first five actions performed (DVs = Total Target Actions, Relevant Target Actions & Irrelevant Target Actions) across age groups (3, 4 & 5) and construal conditions (play vs. problem-solving). Results indicated that imitation of relevant actions did not differ across the three age groups ($F(2, 62) = 1.25$, n.s., $M_3 = 1.80$, $SD = .27$; $M_4 = 1.92$, $SD = .24$; $M_5 = 1.86$, $SD = .28$) while irrelevant actions increased with age ($F(2, 62) = 10.25$, $p < .001$). Post hoc analyses using LSD revealed significant differences between 3-year-olds ($M = 1.69$, $SD = .79$) and 4-year-olds ($M = 2.35$, $SD = .51$; $p < .001$) and 3-year-olds and 5-year-olds ($M = 2.48$, $SD = .51$; $p < .001$), but not between the two older groups ($p = .500$, see Figure 1). Analysis concerning the construal condition (play or problem solving) will be discussed below. Finally, a separate multivariate analysis of variance was conducted to assess the utility of sequence as an alternative coding scheme for the overall imitation score (DVs = total Target Actions (TA) & Pair-wise-sequence

(SQ) scores). The analysis indicated a similar patter of results for the two dependent measures. In both cases there was a significant main effect of age with 3-year-olds differing significantly from 4- and 5-year-olds.

A mixed model analysis of variance was conducted to assess whether there were differences in the *total* number of times each of the five steps was performed at any point in the *demonstration* phase (this is in contrast to the analysis above in which only the first five actions were included) with Age (3-, 4-, & 5-year-olds) and Condition (play or problemsolving) as a between subjects variables. Although the assumptions of sphericity were violated, Greenhouse-Geisser corrections did not alter the statistical decision for any of the effects. The overall analysis indicated a significant effect of Step (F_{Step} (3.22, 200.45) = 17.90, $p < .000$). While the pattern of results suggested a main effect of Age (3s < 4s & 5s) and Condition (open > play), neither of these were significant (F_{Age} (2, 62) = 2.54, $p = .087$, $\eta^2 = .076$; $F_{Condition}$ (1, 62) = 3.25, $p = .076$, $\eta^2 = .050$). Post hoc power analyses indicated power of 0.49 and 0.43 respectively. More importantly, none of the potential interactions approached significance. In particular, there was not a significant interactions between Step and Age (F (6.47, 200.45) = 1.50, p = n.s.) indicating that the relative differences between the five steps did not differ across the three age groups. Finally, follow-up analyses indicated that children preferentially copied those actions that were more likely to be relevant for actually opening the box. That is, children tended to imitate the two relevant actions most (opening the drawer, M_{step5}= 4.13, SD = 1.64 and pulling the pin out, M_{step3}= 4.04, SD = 1.27) followed by the irrelevant actions (pushing the button, M_{step1}= 3.29, SD = 1.37; rotating the lever, M_{step2}=2.82, SD = 1.67 and tapping the pin on the box, M_{step4}=2.49, SD = 1.73, see Table 1). Within-subject contrasts

confirmed that children differentiated between the relevant and irrelevant target actions. Specifically, step 5 was significantly different from steps l, 2 and 4 ($p < .001$) but not step 3 ($p = .628$).

After children failed to open the surreptitiously locked box during the helping phase, most of them (75%) attempted to use some of the other target actions that had previously been demonstrated in the imitation phase. Further, despite one final demonstration of the five-step sequence, children tended, when given their turn, children tended to be constrained by their previous imitation activity. For example, only children who had previously imitated the full sequence did so again after this final demonstration and 21.3% of children used the exact same sequence that they employed in their final trial during the imitation phase (that is the last sequence in which they had attempted to "open" or "play" with the box). Further, children's total imitation score (both sequence and number of target actions) during the imitation phase predicted their total imitation score after the one final demonstration in the helping phase controlling for age and condition (R^2 change = .10, F (1, 54) = 6.52, $p < .005$). Age also uniquely predicted children's imitation score ($R^2 = .14$, F (1, 56) = 8.74, $p < .01$) but condition did not ($p = .183$). Finally, as a statistical alternative, an analysis of variance was also conducted on potential differences in the total imitation score (both sequence and number of target actions) after the one final demonstration during the helping phase with age and condition as between subject factors and total imitation score during the imitation phases as a covariate. Consistent with the pattern of results from the regression analysis, there was a marginal main effect of age (F (2, 51) = 2.50, $p = .092$), no main effect of condition ($p = .56$) and a significant effect of total imitation score during the imitation phase (F (1, 51) =

5.60, $p < .05$). Finally, there was not a significant interaction between age and condition ($p = .123$).

In an effort to demonstrate that motivational processes are relevant for understanding imitation activity, the experimenter construed the imitation phase as either being about "playing" with the boxes or about "opening" the boxes. Possible effects of construal were tested using the same multivariate analysis of variance mentioned above for *Hypothesis 1a*. Recall that this analysis was used to assess differences in the first five actions performed (Total Target Actions, Relevant Target Actions, Irrelevant Target Actions) across age groups and construal conditions. In contrast to the main effect for age on the imitation of *irrelevant* but not *relevant* target actions, we have the opposite, marginal, main effect of condition for the imitation of *relevant* ($F(1, 62) = 3.87$, $p = .054$) but not *irrelevant* ($F(1, 62) = .57$, $p = .452$) target actions. Specifically, children in the problem-solving condition imitated the relevant actions consistently more often ($M_{open} = 1.91$, $SD = .16$) than did children in the play condition ($M_{play} = 1.78$, $SD = .34$). Finally, analysis of the alternative Imitation Sequence score (i.e., all pair-wise comparisons of the first five target actions) produced the same pattern of results for the condition-construal manipulation as the Total Target Action score (Total Target Action score = Relevant Target Actions + Irrelevant Target Actions) but with a significance value that was much closer to .05. Specifically, for sequence scores, there was a marginally significant main effect of condition ($F(1, 62) = 3.64$, $p = .061$) whereas for the Total Target Action score this was well over the .05 significance level ($F(1, 62) = 2.15$, $p = .147$). This suggests that the overall Imitation Sequence Score might be capturing something about the

difference between relevant and irrelevant imitation that is missing from the simple aggregate of the two (i.e., the Total Target Action score).

The second manipulation of motivational processes altered the broader situation from one of imitation to one of helping to evaluate the claim that children over-imitate (imitate irrelevant actions) because they have incorporated those actions into their "causal belief structure" for how to open the box. Accordingly, children's imitation activity on their last trial of the imitation phase was compared to their first trial in the helping phase. In both cases their actions were only coded until they attempted step 5 (opening the box). Four children did not want to respond during the helping phase of the experiment and were not included in the analysis of that phase. Because it is the imitation of irrelevant actions that defines over-imitation, children were categorized as over-imitators if they performed two or more of the irrelevant actions. A Chi-Square analysis indicated that significantly more children over-imitated (N = 53/68 = 78% vs. N = 3/64 = 5%, Figure 2) in the imitation phase than in the helping phase ($\chi^2 = 72.43$, $p < .001$).

Discussion.

Much of the most influential imitation research during the 80s was focused on demonstrating the presence or absence of different imitative abilities at the earliest possible age in an effort to reject Piagetian theory. During the 90s, imitation was used more as a methodological tool for research that was focused on TOM – in particular, on issues concerning children's understanding of other people's mental goals and intentions (i.e., mentalism). This research tended to minimize any consideration of the social-communicative context or potential cognitive dynamics at play for imitation activity in

the types situations in which it was being studied. In response, research over the past decade has been filled with demonstrations that imitation activity is selective, and that the basis of that selectivity depends crucially on both the cognitive and social-communicative aspects of the broader situation. However, in contrast to the seemingly selective nature of imitation, recent research has also demonstrated that children will over-imitate. That is, they will imitate causally irrelevant steps in a sequence of transformations on objects despite "clear" evidence that some of the steps are unnecessary.

In an effort to properly characterize the nature of imitation, the contrast between selective and over-imitation would seem to be paradoxical: how can children be both intelligent, flexible, selective imitators and also automatic, rigid, over imitators. The answer is to recognize that the two types of imitation manifest in very different types of situations and at very different ages. Therefore, the *developmental* question in need of an answer is why older children tend to over-imitate while younger children tend to selectively imitate, and further, why the type of situation is relevant to that developmental shift.

To answer the developmental question, previous researchers have suggested that sometime around the second year of life children undergo a general transition in which the dominant function of imitation activity shifts from serving a cognitive function to serving a social function (Uzgiris 1981; Neilsen, 2006). The idea here is that over-imitation (the imitation of causally irrelevant steps when learning about an object) is a consequence of children using imitation as a form of social activity (playing the imitation game). For example, when learning about how to open a novel box, they might imitate the irrelevant steps as part of wanting to socialize, not as a consequence of how they

think the box actually works. However, Lyons and colleagues (Lyons, et al., 2007; Lyons, Damrosch, Lin, Macris, & Keil, 2011) have provided a number of studies to test the social function interpretation and concluded that over-imitation is in fact a consequence of changes in the child's causal-belief structure about the box itself.

Imitation activity: Cognitive and motivational aspects.

The major impetus of the current project has been to begin to model imitation activity as a psychological process with a "complex cognitive reality". This has involved applying the interactivist framework in an effort to re-interpret and re-organize much of the developmental imitation literature as well as provide an account of over-imitation that is consistent with earlier selective imitation. The interactivist approach conceptualizes imitation as a heuristic form of problem-solving in which children make use of adults as a resource for ongoing and future activity. From this perspective, all imitation is inherently abstract, and, therefore, it is necessarily selective. Consequently, imitation activity must involve some selection for what to imitate over what not to imitate. That selectivity will itself depend on what the child understands about the situation, which will involve the interplay between cognitive and motivational aspects. All of this will apply to what children have learned about objects as well as what they have learned about social interactions in different types of situations.

Cognitive aspects. Three- to 5-year-old children come to an experimental imitation situation with a wealth of previous learning and experience with respect to both objects and social interactions. Social activities inherently involve a broader situation and when these are "novel" there will be uncertainty about how to proceed; however, such uncertainty will not be absolute. That is, in a novel situation, children may not have

a well-defined idea about what is going on, but how they proceed will be massively influence by what they do understand about the "novel" situation. The first half of the results were geared towards demonstrating the importance of what children bring to an experimental imitation situation. In particular, how does their existing understanding of an object influence their presumptions of relevance about how a novel box might operate.

Results indicated that the *relevant* target actions were imitated consistently across the three age groups while there was a developmental increase in children's imitation of *irrelevant* target actions between 3- and 4-years of age (Figure 1). Further, the pattern of results showed that all children preferentially imitated the *relevant* over *irrelevant* actions but only for 3-year-olds was this difference significant. What this suggests is that children's prior understanding of how boxes tend to operate influences what they select to copy during imitation situations. That is, despite the novelty of the box, even the youngest children make heuristically guided presumptions about how the box works such that it influences their selection of what to imitate.

Recall also, that these analyses were conducted on the first five actions that the child performed in an effort to minimize the possibility that children were learning about which transformations were (and were not) relevant for opening the box. Further, there was no clearly consistent progression from more imitation to less imitation across the four training trials at an individual differences level. Finally, the heuristically guided presumptions interpretation is further supported by the within-subjects analysis of differences in the total number of times that each of the 5 steps was reproduced at *any* point throughout the training phase. The step (step 4 - tapping) that was least likely to be relevant for opening the box was imitated the least followed by the other two, more

likely, but equally irrelevant steps (steps 1 – button press & 2 – lever rotation), with the two relevant steps (steps 3 – pin pull & 5 – open drawer) being imitated the most.

Motivational aspects. The fact that children did not "weed out" the irrelevant steps over the course of the four training trials would seem to be consistent with Lyons' interpretation of over-imitation as resulting from changes to the child's causal-beliefs about how the box operates. However, the causal-belief interpretation assumes that all relevant aspects of the situation are instrumental for openi ng the box: an assumption that is false. Natural pedagogy has aptly demonstrated that standard imitation situations have a number of social-communicative markers that orient children's understanding of what type of situation they are involved with. This orienting helps them to interpret the purpose of the situation and facilitate how to act "successfully" when given their turn. From the interactivist perspective, the child's understanding of the purpose of the situation is going to involve both cognitive and motivational aspects. Therefore, children will use what they already know about objects and types of social situations, along with any corresponding motivations, to interpret how to successfully interact in this particular situation.

Two manipulations were used to illustrate the relevance of motivational aspects for the phenomenon of over-imitation. The rationale was that changes in the type of situation have corresponding changes in the underlying motivations involved. Most imitation studies with older children have an object focus that presupposes that children are instrumentally motivated to reach some outcome and interpret their results accordingly. The current claim is not that motivational aspects are operative independent

of cognitive aspects, nor that they are uniform (always instrumental), but rather that motivational aspects are an essential variable for interpreting imitation activity.

The first "motivational" manipulation was a subtle difference in how the experimenter characterized their demonstration of the box to the child: as how to "play" with the box or how to "open" the box. In all of our analyses, children in the *open* condition imitated with higher fidelity than those in the *play* condition; however, this difference only approached significance with respect to relevant target actions. That is, children in the *open* condition imitated the relevant actions of the demonstration with higher fidelity than those in the *play* condition. One interpretation of this finding is that the greater instrumental motivation of the *open* condition induced an understanding of the situation in which the focus should be on those steps that were presumed to be most relevant for opening the box (i.e., the relevant steps).

However, despite a consistent difference between *open* and *play* conditions, the overall effect tended to be relatively modest. The subtlety of the effect is likely due to the weakness of the manipulation itself as well as to a lack of consistency in how the imitation situation was characterized by the experimenters. In transitioning from warming up to the experimental task, all of the activities were referred to as games. Children were asked if they were ready to play some new games and often times while setting up the boxes these were referred to as the "boxes game". However, once the boxes were set up, experimenters consistently used the more ambiguous phrase: "let me show you how this works. I'm going to take two turns and then you get two turns". Finally, the explicit variable was not manipulated until the end of the demonstration when the experimenter said "there, that is how you open/play with the box". In sum, many

factors contributed to the situation being about *playing* games and so the fact that our modest manipulation of the word "open" versus "play" had any effect at all is of interest.

The second manipulation of motivational aspects was more profound and consequently, so too was the effect. This change in motivation was derived from a change in the broader type of situation from imitation to helping. In the helping phase, opening the box becomes decidedly instrumental relative to the broader motivation for helping the adult experimenter. Accordingly, nearly 80% of children in the imitation phase over-imitated, while this number dropped to less than 5% in the helping phase.

This finding is in stark contrast to Lyons et al.'seagues efforts to demonstrate that over-imitation is not a matter of changing motivations, but rather involves changes to the child's causal-belief structure (Lyons, et al., 2007; Lyons, et al., 2011). However, our a priori critique of his research claimed that it failed to adequately manipulate motivational aspects precisely because of its broader failure to recognize that children are learning about the box as part of a social interaction that, as a whole, defines the situation.

Summary. From the interactivist perspective, children learn about how to successfully interact in types of situations and this learning involves both motivational and cognitive aspects. Therefore, the dramatic shift in over-imitation across situations in the current study is not just due to changes in motivations. Success is a normative notion with multiple layers regarding what children are learning about. Consequently, learning about the box per se is tied to what children are learning about the broader situation. To put it simply, children are learning that "this is what you do in this type of situation" rather than that "this is the causally necessary way to open the box". Recent evidence using the same basic procedure has actually demonstrated that adults will imitate causally

irrelevant steps with even higher fidelity than young children (McGuigan, Makinson, & Whiten, 2011). These findings provide converging evidence that over-imitation in children is less about the causal workings of the box and more about the broader situation.

Research Question 2: Mentalism

Does success on Buttelman et al.'s active helping paradigm demonstrate that children are acting on the basis of the adult's false-belief. Further, does young children's ability to make assumptions regarding what an adult is trying to accomplish depend on their familiarity with the objects involved and their understanding of the broader scenario?

Coding.

In general, children were coded as selecting the toy for their attempt to help E2 (the confederate experimenter) if they attempted to open the box with the toy in it. However, some of the children who selected the empty box in the FB condition were also coded as selecting the toy as the goal of E2 (i.e., what E2 wanted). The reason for this was that some of the older children seemed to be playing out the trick scenario to its logical conclusion rather than helping the adult achieve their goal. That is, these children seemed to want E2 to have to open and find that the box was empty and that the toy was gone. When originally asked by E1 to help E2, these children would do things like point to the (now) empty box and say "Open that box"; or pull out the pin from the (now) empty box, back away, and say "look in there". Alternatively, one child opened the empty box saying "it's not in here, lets check in the other one". These children tended to

have smiles on their faces and were looking up at E2 as they acted on the box in contrast to focusing on E1.

Accordingly, a set of formal criteria was established to decide whether children who seemed to be playing out the trick scenario by going to the (now) empty box nevertheless knew what E2 wanted. First, when asked if they knew what E2 wanted they had to correctly respond that he/she wanted the toy. Second, once prompted to help, they had to respond quickly (within 5 seconds or less) and without an additional prompt indicating that they had a definitive idea about how they wanted to "help". Finally, they had to do something to indicate that they wanted E2 to be the one to open the box (e.g., explicitly tell them, remove the pin and step back looking at E2, etc.). The following criteria were satisfied by a total of 6 children (three 5-year-olds, two 4-year-olds & one 3-year-old) and these children were "re"-coded as selecting the toy as the goal of E2.

Analysis.

Two related conditions were used collectively to test the mentalistic and the non-mentalistic interpretation of what constitutes the basis for children's behavior in the active helping procedure. Initially, a binary logistic regression analysis was used to look at whether Age (3-, 4-, & 5-year-olds) and Condition (FB – False-Belief, CV – Clairvoyance, & HF – Hands-Full) predicted what location the child selected (the box with the toy or the empty box). Neither of the predictors (nor the interaction) was significant. However, due to a relatively small number of participants in each of the nine cells (n = ~7.5), subsequent statistical analysis was conducted using the chi-square test for independence. Three, four, and five-year-olds were each analyzed separately to examine whether children's box selection was independent of their condition assignment.

For each age, if Condition and Location were significantly related, then two planned comparisons were conducted that correspond with the two hypotheses: the first comparison was between FB and CV while the second compared CV with HF.

A chi-square test of independence indicated that the pattern of responding by 3-year-olds did not differ significantly across conditions ($\chi^2 = .038$, $p = ns.$). Specifically, children in all three conditions overwhelmingly selected the box that currently contained the toy (FB = 87.5%, CV = 90% & HF = 87.5%). This result replicates the FB condition from the original study by Buttelmann and his colleagues.

A chi-square test of independence indicated that responses by 4-year-olds did not differ significantly across conditions ($\chi^2 = .038$, $p = ns.$); however, the pattern of results was not uniform. In the FB and CV conditions children preferentially selected to open the box containing the toy (FB = 71.4% & CV = 85.7%), while in the HF condition they did not (HF = 42.9%).

Finally, a chi-square test of independence indicated that responses by 5-year-olds were significantly different across conditions ($\chi^2 = 11.87$, $p < .005$). Consistent with the pattern from 3- and 4-year-olds, 5-year-olds preferentially selected to open the box containing the toy for FB and CV conditions (FB = 100% & CV = 85.7) but not in the HF condition (HF = 25%). A follow-up chi-square comparing the CV and HF conditions indicated that these conditions were significantly different $\chi^2 = 9.60$, $p < .005$.

Summary. Results from the helping task indicated a transition between three and five years of age. While the youngest children indiscriminantly selected the toy in their effort to help E2, 5-year-olds were better able to adjust their helping behavior in accordance with the broader scenario. Finally, 4-year-olds performed somewhere in

between. Further, as age increased, performance in the false-belief condition worsened slightly in that these children did not select the toy in their effort to help E2.

Discussion.

Due, in part, to the controversy surrounding the adequacy of looking procedures (Allen & Bickhard, in-press), some researchers have sought alternative paradigms. In particular, Buttelmann et al. (2009) have argued that the "active action paradigms" provide stronger evidence for a given ability than do "passive looking paradigms". The classic example of an active action paradigm is Meltzoff's (1995) failed-attempts procedure that was used to investigate children's understanding of others' intentions. The general idea is that, if children act in ways that *require* reasoning about another person's mental states, then there is less ambiguous evidence that they in fact possess knowledge of those mental states. The crucial issue then becomes whether or not acting "correctly" does in fact *require* the presumed reasoning about mental states or whether other non-mentalistic aspects of the situation are sufficient for such action. The current project attempted to provide some empirical evidence for the conceptual critique of the active helping procedure used by Buttelmann et al. (2009).

In the original procedure, Buttelmann et al. demonstrated that children would help an adult by retrieving a toy that had been moved in the adult's absence rather than by helping them open an (now) empty box that the adult attempted to open. This preferential helping was interpreted as an indication that the child understood that the adult wanted the toy because, upon their return, they attempted to open the box where the toy was previously located. That is, children understood that the adult was searching in accordance with their (false) belief about the location of the toy. Our basic challenge to

the active helping procedure was the claim that children do not need to know/reason about the (false) beliefs of the adult in order to "correctly" help them retrieve the toy. Two related conditions were collectively used to test these two alternative interpretations for what constitutes the basis for children's helping behavior in this type of social situation.

The clairvoyance control condition was used in an effort to directly test the false-belief interpretation in a way that does not conflate other aspects of the experimental situation (i.e., the broader scenario, the salience of the toy, etc.). If children are in fact using a false-belief to interpret the adult's goal when they try to open one of the boxes, then that should hold whether the false-belief implies that the adult wants a toy or an empty box. Results from the clairvoyance condition indicated that children from all three age groups uniformly opened the box with the toy in it rather than the now empty box, which is what the adults *must* have wanted if they were acting on the basis of their false-belief.

While it might seem strange for an adult to want an empty box, children in Buttelmann's original true belief condition were willing to help an adult achieve such a goal given that the adult clearly did not want the toy (recall that for the true belief condition the adult did not leave the room when the toy was moved and so "knew" where it was). However, the strangeness of this is precisely why the broader scenario and salience of the toy are relevant. Some possibilities for what a person might want in a given situation are intrinsically much more likely than others.

For example, when you enter an ice cream parlor and an employee asks: "how can I help you", they have a certain space of relevant possibilities in mind for what you are

likely to want. Perhaps you will ask for chocolate or vanilla ice cream or maybe where the washroom is located; however, nowhere in this space will be a desire for an oil change or a question about renewing a driver's license. Further, the space of relevancies regarding the potential goals of a person in a situation is always fallible and open to adjustment (maybe the ice cream store is a front for making counterfeit driver's licenses). The point, then, is that coming to know the relevant possibilities for what people are *likely* to want in a given situation is going to be a consequence of learning: both in terms of what has been learned about objects and people in general but also how that learning relates to specific types of situations (the affordances for Wayne Gretzky's hockey stick sitting in the hockey hall of fame are very different from those of the hockey stick currently leaning against the wall in my bedroom – at least they better be if you want to avoid a mob of angry Canadians).

Accordingly, the hands-full condition attempted to demonstrate how the broader scenario helps define the meaning of various aspects of the situation. In this case, we used a hiding scenario that would make wanting an empty box a relevant (potential) goal of the adult. Our results indicated that changing the scenario from being about playing a trick (which makes the toy most relevant) to hiding toys from Oscar (which makes the empty box most relevant) changed how children understood what it *might* have meant to help the adult when watching them try to open the (now) full box. That is, in contrast to the clairvoyance condition children now had a reason to preferentially open the (now) empty box.

Much of the power of the hands-full condition comes from its flipping of the effect that was found for the clairvoyance condition. That is, except for the type of

scenario, the clairvoyance and hiding conditions were identical in terms of where the toy was located and which box the adult tried to open upon their return. That children tried to help the adult by opening the other (now) empty box demonstrates that the broader situation provides an essential influence on how children understand the situation, and it illustrates the subsequent influence that this has on their helping behavior.

The HF condition, in isolation from the CV condition, demonstrates that a false-belief interpretation of helping behavior is not necessary. This alone is very important because the research by Buttelmann et al. (2009; 2011) does not even allow for the conceptual possibility that children might be able to "correctly" help without invoking some form of mentalism/mindreading. That is, they assume a priori that the only relevant theoretical considerations concern *which* mental states might be involved (e.g., true-beliefs, false-beliefs, an ignorance representation, etc.) and pursue their empirical research on that a priori basis.

While it is always possible to overlay a false-belief rendering of the HF condition, any such interpretation would be wholly superfluous (i.e., it makes no difference to the child's behavior whether they are also posited to be reasoning about false beliefs). Further, it is in conjunction with the CV condition that these results provide compelling evidence against the original FB interpretation of Buttelmann and his colleagues in particular and against the adequacy of the active helping paradigm to demonstrate false-belief reasoning more broadly.

Finally, additional evidence that the helping paradigm (in its current form) may be inadequate for testing what children know about false-beliefs is provided by the variations (or lack thereof) that were found for the different age groups. First, consider

that, initially, there was no improvement with age for the replication of the original FB condition. That is, the number of 3-, 4-, and 5-years who failed to "correctly" open the box with the toy remained constant. Given the massive research literatures suggesting that mentalism/mindreading improves with age (with a particularly relevant transition between 3- and 4-year-olds), one would expect older children to perform better than younger children on the same task. The fact that there is no difference across age groups (or if Buttelmann's three age groups are included, then younger children actually do better) and that the known transition between 3- and 4-year olds is wholly absent, would suggest that the active helping paradigm does not involve reasoning about false-beliefs.

Further, the fact that 3-year-olds did not change how they helped the adult across any of the three conditions suggests that they were uniformly drawn to the toy for how to help. However, the TB condition from the original study by Buttlemann et al. (2009) does demonstrate that younger children (i.e., 18- & 30-month-olds) are not totally indiscriminant in their assumption that the toy is the way to help. When children had definitive evidence that the adult did not want the toy – that is, when the toy was pitted against where the adult searched and contextualized, not by a scenario per se, but by the implications of visual access – they preferential selected the empty box. That is, because the adult watched the child move the toy to the other box, if the adult went to the (now) empty box, they must simply want access to that empty box despite the child not knowing the reason.

Finally, the HF condition involved a developmental trend from 3-5-years of age in which children's preference for selecting the "correct" (empty) box flipped. Specifically, all but one of the 3-year-olds continued to retrieve the toy in the HF condition despite

having a "good" reason to assume that the adult did in fact want an empty box; 4-year-olds were about 50/50 while 5-year-olds had the opposite box-selection as the 3-year-olds (i.e. almost all of them "correctly" opened the empty box). This finding is particularly troublesome for the false-belief perspective because it demonstrates that even when there is a sensible reason for the adult to want an empty box *and* wanting the empty box is consistent with them acting on the basis of their false-belief, 3-year-olds still opened the box with the toys. In contrast, I have no problem biting the bullet on the idea that 3-year-olds do not understand the broader scenario well enough to correctly interpret the adult's actions. Instead, despite the scenario (and the adult's false-belief), 3-year-olds were uniformly drawn to where the toys were located which is also where the adult's attempted opening activity took place.

Summary. The study by Buttelmann et al. (2009) neglected to consider non-mentalistic interpretations of their results. From a non-mentalistic perspective, children are considered to be learning about types of situations, and what distinguishes the different testing situations is that a trick is played in one of them but not the other.. Further, a toy will offer a particularly salient possibility for how to help someone, especially when the only other alternative is an empty box. While the TB control condition from the original study did provide evidence that children will not *always* assume that the toy is how to help the adult, they failed to explore the scope of that assumption beyond their mentalistic framework. In the current study, the findings for 3-year-olds consistently demonstrated that unless children are *confident* that the adult does not want the toy (i.e., the TB control in which the adult has visual access), they seem to assume that the toy is a good choice for how to help the adult. While 4- and 5-year-olds

increasingly demonstrated the influence of the broader scenario on how they understand the situation and thus on how to help the adult, there was no evidence that they were ever acting on the basis of the adult's false-belief. In sum, young children's decision for how to help the adult in the active helping paradigm seems to be based on what the adult is doing, what is salient about the situation, and how these relate to the broader context as defined by the scenario.

Research Question 3: Reflection

Does children's ability to reason in terms of the mental states of another person require internal reflection and is this capacity available prior to age 3.5-4? In particular, can children explicitly reason about the relationship between objects in a novel situation? Further, as a simpler manifestation of internal reflection, will children who are unable to reason about object relations tend to do poorly on TOM tasks?

Coding: Leaning Blocks.

The leaning blocks task had five parts. The three *perceptual* variants and the two *structural* variants were summed separately, standardized, and then combined to form the child's Object Reasoning (OR) score. Any children who failed to answer the control questions for the perceptual variants were scored with an 'F' and were excluded from analysis. For example, for the first perceptual variant question, if the child could not correctly answer what would happen to either of the single blocks in isolation, then they were given an 'F'. Further, any children who did not correctly answer both sub-questions for each of the two structural variants were scored with a 0. For example, for the first structural variant question, if the child correctly answered what would happen to the white block (stay up) but was incorrect for the brown block (stay up), then they were

scored as 0. The reason for this was to guard against children getting one of the sub-questions correct by simply giving the same response twice. A total of 14 children were excluded from the analysis: 3 because they did not do the task at all, 7 because they received at least one 'F' and only did part of the task, and another 4 because they received at least one 'F'.

Analysis: Leaning Blocks.

Two linear regression analyses were used to test whether there was a single transition between 3- and 5-years of age on the leaning blocks task. The Age variable was dummy coded to enable exploration of the non-linear nature of the predicted transition. Specifically, that 3-year-olds will fail the task while 4- and 5-year-olds will pass the task equally. Results from the analyses indicated that Age was a significant predictor of performance on the leaning blocks task ($F(2,58) = 19.75$, $p < .001$, adjusted $R^2 = .39$). Further, 3-year-olds differed ($M_{3\text{-year-olds}} = .75$, $SD = .51$) significantly from 4- and 5-year-olds ($t(58) = 4.50$, $p < .001$ & $t(58) = 6.02$, $p < .001$) while 4- and 5-year-olds ($M_{4\text{-year-olds}} = 1.45$, $SD = .42$ & $M_{5\text{-year-olds}} = 1.66$, $SD = .39$) did not differ significantly from each other ($t(58) = 1.23$, $p = ns.$).

Coding: TOM.

Three tasks were used to assess children's false-belief understanding: Unexpected Contents (UC), Change of Location (CL), and Active Deception (AD). For both of the first two tasks, children were scored as passing or failing the test question (1 or 0). However, children who failed either of the control questions for either task were automatically given 0 for that task. Finally, the active deception task was scored out of 4 and standardized. A correlation analysis indicated that the three false-belief tasks were

significantly related (UC & CL, r = .59, $p < .001$; UC & AD, r = .58, $p < .001$; CL & AD, r = .62, $p < .001$) and so a composite Theory of Mind (TOM) score was created for a maximum total score of 3 (1 for each task).

Analysis: TOM.

An analysis of variance was used to determine if there were Age difference for children's performance on the TOM tasks. Results indicated a main effect of age ($F(2, 57) = 32.73$, $p < .001$, adjusted $R^2 = .52$). Further, all three age groups differed significantly from each other ($p < .005$, $M_{3\text{-year-olds}} = .24$, SD = .50; $M_{4\text{-year-olds}} = 1.10$, SD = .90, $M_{5\text{-year-olds}} = 2.18$, SD = .87).

A multiple regression analysis was conducted to determine if reasoning in different domains might be related to a general shift in children's ability to use internal reflection to think about possible outcomes. Results indicated that Object Reasoning (OR) significantly improved the prediction of children's TOM understanding above and beyond that of Age alone (R^2 change = .07, $F(1, 57) = 42.38$, $p < .001$).

Discussion.

A major theoretical constraint on the interactivist knowing levels model is that certain forms of knowledge require internal reflection. For example, the *necessity* of the fact that "2 + 2 = 4" simply cannot be learned from interacting with the external world directly. Therefore a second level knowing system must exist that can interact with first level knowing in a fashion similar to how first level knowing interacts with the external environment. In humans, second level knowing constitutes internal reflection and enables the possibility of reasoning about non-actual circumstances. That is, the general possibility of counterfactual reasoning requires the capacity for internal thought (second

level knowing). In turn, the requirements for second level knowing are architectural (rather than functional) and thought to involve a maturational development around 3.5-4 years of age (Campbell & Bickhard, 1986).

There are a number of domains in which a significant developmental shift seems to take place between 3- and 4-years of age (Bickhard, 1992a). One such transition concerns the ability to reason explicitly about the false-belief states of other agents in novel situations (i.e., TOM research). While there is much debate concerning the exact nature of the transition between 3- and 4-years of age, few researchers claim that children younger than three cannot reason about *any* of the mental states of another person (intentions and goals as well as beliefs and desires). However, a major theme running throughout the current paper is that the wealth of experimental research purportedly demonstrating early mindreading abilities (i.e., mentalism) is diagnostically insufficient to draw those conclusions.

The possibility that young children do not engage in any mental state reasoning despite their ability to navigate their social environment is slightly less outrageous if we consider comparative researchers who argue against TOM abilities in animals. Many animal species are socially competent in ways that allow for sophisticated social coordination. To the extent that these competencies can be understood without the need to posit a theory of mind, they provide an existence proof for the types of social complexity that can be accounted for by non-mentalistic frameworks.

A consistent trend for early developmental psychology over the last 40 years has been a progressive backing off from overly rich interpretations forced by the advent and testing of leaner possibilities. In part, this is the nature of science, but in part, it is a

reason for pause. Another major theme running throughout the current paper is that many of the assumptions from the broader theoretical frameworks used to study early cognitive and social cognitive development are conceptually inadequate. Scientific progress involves experimentation but it equally involves dealing with the theoretical frameworks that motivate experimentation, influence its design, and provide the context for its interpretation.

Interactivism offers an alternative theoretical framework with multiple theoretical implications for how to understand the mind. The Leaning Blocks (LB) task was based on an empirical implication of the knowing levels model within the interactivist framework. The power of the LB task comes from its extreme idiosyncrasy. Contrary to our intuitions and contrary to existing developmental research with infants (Hespos & Baillargeon, 2008; Needham & Baillargeon, 1990), results from the LB task indicate that children younger than 4-years of age are unable to reason explicitly about object properties and their relations. Further, not only did 4-year-olds perform better than 3-year-olds but they were not different from 5-year-olds. The ceiling effect from performance on this task after 4-years of age suggests that the LB task is a relatively pure measure of reflection with few additional extraneous performance factors necessary for success.

The simplicity of the LB task (beyond the necessary reflection capabilities) makes it a good measure of the development of second level knowing. Second level knowing involves a maturational change that *enables* the possibility of reflection that then has a cascade of potential further influences within different domains. Therefore, the predicted synchrony for a uniform developmental transition across domains is not forced by the

knowing levels model per se; rather, the potential for synchrony derives from the fact that it is an architectural change (i.e., brain maturational).

Results from the current study indicated that children's explicit object reasoning abilities (i.e., reasoning within the physical domain) uniquely predicted their capacity to reason about another person's mental states (i.e., reasoning within the social domain); however, the relationship only accounted for 7% of the variance. There are two potential reasons for the small value of R^2: First, the nature of the relationship between age and LB is that of a threshold that differentiates between children capable of reflection and those who are not. In contrast, the relationship between age and TOM is linear, involving a whole host of other abilities (Stone, Carpendale, Sugarman, & Martin, in-press) such that children continue to improve across all three age groups (i.e., 3-year-olds < 4-year-olds < 5-year-olds). Second, the host of additional abilities necessary to pass TOM tasks means that they are a relatively noisy as a measure of reflection.

Summary. If knowing is fundamentally a matter of interactive competence (as interactivism would have it), then certain forms of human knowledge are going to require an architectural brain development that enables a second level knowing system to interact with the first level system in a fashion similar to how the first interacts with the world. Such a development was originally predicted in the early 70s (Bickhard, 1980b) and can be used to interpret a wealth of developmental research since then that has consistently demonstrated an important developmental transition between 3- and 4-years of age. Children's performance on the leaning blocks task extends this consistently found transition between 3- and 4-year-olds but in a domain and with a task that would be predicted by all extant theories to have developed years earlier. Most broadly, these

results demonstrate the potential value in reconsidering what can be accomplished by children without the need to attribute to them the cognitively sophisticated ability to reason about the perceptually hidden mental states of others.

CHAPTER 5: GENERAL DISCUSSION

Science involves experimentation, but it equally involves dealing with the theoretical frameworks that motivate experimentation, influence its design, and provide the context for its interpretation. Consequently, the current paper has provided an in depth analysis of how the dominant, largely taken for granted, folk psychology framework has influenced experimentation. One of the main conclusions from this analysis is that experimental research concerning social-cognitive development has not tended to differentiate between alternative non-mentalistic interpretations of phenomena. Interactivism provides an alternative theoretical approach to social-cognition in general and to imitation activity in particular.

The experiments presented in the current paper were a manifestation of some of the relevant differences between interactivist and folk psychological frameworks. Interactivism has provided the current project with a rich cognitive ontology for modeling imitation activity that has demonstrated how the "phenomenon" of over-imitation may have been mischaracterized. The other two experiments challenged the adequacy of helping procedures to demonstration false-belief understanding and the possibility of any mindreading before 3.5-years of age respectively. Therefore, all three experiments are of independent interest at the level of the phenomena being explored (imitation, mindreading, reflection, and their interrelations), but their ultimate purpose in the current paper is as a demonstration of the value of considering an alternative theoretical perspective on social-cognition in general.

Social Life is Normative

With a greater appreciation for the heterogeneity of social activity and relevance of social contexts comes an increased skepticism that folk psychology (as the ubiquitous ascription of intentional states for the purpose of interacting with other people) is an appropriate framework for understanding how adults (let alone children or non-human primates) navigate their social environments (Hutto & Ratcliffe, 2007). Ratcliffe (2009) argues that social coordination in everyday interpersonal engagements can only be properly accounted for by recognizing the necessary role of shared knowledge in different types of situations. This shared knowledge includes the normative guidance necessary for things like riding the sub-way, driving a car, or ordering coffee at Starbucks, but also extends to shared knowledge about social roles (in the lab, the graduate student will run the participants) and artifact functions (a box is for storing items). In all three classes of shared knowledge, the normative aspects regarding what you are likely to do is independent of any particular person and makes reference to mental-states generally superfluous.

Ratcliffe's analysis has potentially profound implications for the field of social cognition because it appears to challenge the psychological reality of the very phenomenon that is purportedly being studied by Folk Psychology (FP) researchers. As a consequence, Ratcliffe's challenge highlights that the actual phenomena of social cognition are social interaction (of which there are many types) and that FP constitutes a theoretical framework for how to understand those social interactions. There are two main reasons for the confusion between FP as a theoretical framework and social interactions as the phenomena being studied: First, there have been relatively few alternative approaches to social cognition. Second, the history of TOM research did not

begin with a detailed exploration of social interaction and come to FP as a conclusion. As Ratcliffe succinctly puts it: "What I am looking for here is an argument that arrives at FP through a study of social life, rather than an argument that arrives at FP through a debatable set of philosophical presuppositions and then proceeds to impose it on social life" (p. 241).

Regardless of the adequacy of Ratcliffe's strongest conclusions, the relevance of his FP critique for the current study is two-fold: (1) to highlight that experimental research concerning early social cognition (including imitation) is constrained and motivated by the assumed ubiquity of FP as part of social life in general; (2) that non-mentalistic alternative proposals concerning social situations in general provide alternative conceptual resources for understanding imitation research in particular.

The Influence of the Assumed Ubiquity of FP

The influence of whether researchers assume a FP end-state (or not) is evident in the contrast between the *non-mentalistic differentiations* that have derived from research on animals (no assumption of a FP end-state) versus the *mentalistic differentiations* that have derived from research on children (assumption of a FP end-state). The problem this raises for mentalist researchers is two-fold: first, *how* (not just when) and *why* do we transition from non-mentalistic to mentalistic social interaction; and, second, much experimental research does not differentiate between mentalistic and non-mentalistic interpretations and therefore does not adequately control for non-mentalistic alternatives. Further, the failure to adequately control for non-mentalistic alternative interpretations has been empirically demonstrated for some of the most influential mentalistic procedures (Huang, et al., 2002, 2006; Sirois & Jackson, 2007).

Traditionally, the opposition to a mentalistic perspective on matching behavior (i.e., imitation) has come from researchers who draw on the social learning taxonomy that has been constructed by animal researchers over the last century (Byrne, 1999). Their non-mentalistic interpretations tend to demonstrate the adequacy of emulation or stimulus enhancement controls in an effort to rule out imitation as being operative in a given experimental situation. However, these efforts do more to classify forms of social learning behavior than they do to provide any insight into the "complex cognitive reality" of imitation as a psychological process (whether involving mentalism or not).

The more recent exploration of imitation in developmental psychology over the past decade has aptly demonstrated that additional non-mentalistic factors are relevant for imitation activity; however, this research does not tend to argue against the *potential* role of mentalism for imitation in general. Further, mentalism is often considered to be constitutive of imitation. That is, "true" imitation is thought to differ from other forms of social learning in that the former requires an understanding of the mental goal/intention of the model. Specifically, the mental goal/intention provides the meaning to a social situation and imitation then proceed directly on the basis of that understanding. In contrast, from the interactivist perspective, early imitation is inherently non-mentalistic. Reasoning about the mental states of an agent requires reflection and this capacity is not available until around 3.5-years of age. The purpose of the leaning blocks task was to provide support for the claim that the cognitive limitations (i.e., no reflection) demonstrated by standard false-belief tasks extend not only to the more "basic" mental states (i.e., goals and intentions), but also to other domains (i.e., physical reasoning). From the interactivist perspective, imitation still proceeds on the basis of the child's

understanding of the situation, but this understanding has a dynamics that does not fundamentally involve the attribution of any mental states. The contributions of the current paper have been to use interactivism's non-mentalistic framework for understanding social situations to try to better understand imitation activity as a process that also does not involve mentalism. The interactivist models of representation, motivation, and learning provide a robust cognitive ontology to begin to explore some of the "complex cognitive reality" of imitation as a psychological process.

Interactivism as an Alternative Framework for Understanding Social Life

The second point of relevance for Ratcliffe's FP critique was that non-mentalistic alternative frameworks for understanding social situations in general also provide an alternative perspective for understanding imitation activity in particular. Interactivism is an embodied, action-based approach to cognition in which anticipation forms the core of representation. Specifically, knowledge competence is constituted by successful anticipations of potential future interactions with the world. This applies to the world of people as much as it applies to the world of inanimate object; however, there are also important differences between the two. Unlike objects, your representation of other people depends crucially on their representation of you. Therefore, to determine the interactive affordances in a social situation requires that the participants coordinate their individual perspectives through a mutually shared understanding of the situation (Bickhard, 2004). The examples from our discussion of Ratcliffe illustrate the ubiquity of this shared knowledge regarding social context, social role, and artifact functions.

From this perspective, attributing internal states to other people in order to understand their behavior becomes as irrelevant for social situations as it is for knowing

about objects. That is, just as there is no need for people to attribute internal states to objects in an effort to know them (i.e., understand their interactive potentialities), there is no need for people to attribute internal mental states to each other in order for them to coordinate their activity (i.e., engage in successful social interactions). Therefore, social cognition is fundamentally a matter of shared knowledge in the sense of mutually held interactive potentialities (i.e., shared practices). Further, just as the interactive potentialities afforded by balls will come to be differentiated from those that are afforded by blocks, so too must the affordances of an imitation situation come to be differentiated from those of an eating routine. Therefore, the *development* of social cognition is fundamentally a matter of learning about the differentiations and subsequent interactive potentialities for different types of situations. Finally, once a type of situation is sufficiently well understood (e.g., imitation situations) it can be used recursively to facilitate additional learning and development. The potential for this type of recursive learning is why, for interactivism, imitation has been characterized as a form of learning to learn (self-scaffolding).

Limitations

The current study has several limitations (some of which have already been mentioned). The very different performance profiles from 3-,4- & 5-year-olds in the helping task suggests that these age groups cannot be collapsed and must be considered separately. Accordingly, the totally number of participants available for a logistic regression with age and condition as predictors was not sufficient.

Further, embedding the imitation task within the helping task may have made opening the box a more salient possible goal than would otherwise have been the case.

Children received a very elaborate turn taking demonstration for how to open the box. That is, learning how to open the box became an interesting game in and of itself. Therefore, when children were later given an opportunity to help the adult, they may have been more likely to see opening the box as a legitimate possibility, especially for those children who were confused about the broader scenario.

The extremely subtle implementation and partial conflation of the first motivational manipulation was not ideal. In terms of conflations, construing the demonstration of how to open the boxes as a game for all participants was probably a mistake. The opening of the boxes should only have been construed as a game for the children in the play condition. Further, it may have been better to have had an object inside the boxes for the problem-solving condition so that the purpose could have been to retrieve the toy.

It would have been preferable to have independent samples of how salient each of the manipulations was independent of any purpose. That is, do children have differential preferences for how interesting they find each of the five object transformations. For example, is rotating the lever inherently more interesting than pushing the button. Further, just like research that considers the frequency of a word when doing a lexical decision task, it would be nice to have some sort of a priori quantification for how likely each of the transformation was for opening the box.

Finally, for the leaning blocks task, it would have been desirable to be able to counterbalance the order of presentation of the 5 sub-tasks. Additionally, it would have been useful to have a few more task variations for the creation of the total leaning blocks score. Further, children were always prompted so that they would get the three

perceptual variants of the task correct if they simply copied the last thing that I said during the target question. For example, after asking what the block will do when I let go, children who did not respond would be prompted with "will the blocks fall or stay up". This ordering of the prompt was intentionally set up to bias performance away from results that would support our hypothesis, but, upon reflection, it seems more appropriate that children who try to answer by copying the last part of the prompt should be scored as getting the answer incorrect.

Future Empirical Directions

The current study has been focused on understanding how the cognitive and motivational aspects of imitation relate to different types of situations. However, this takes for granted the fact that children have *already* learned that they can use adults as a resource for further activity. In the future, I would like to investigate more closely the developmental basis of this assumption. Gergely and his colleagues have made some exciting discoveries about the social-communicative markers that adults use to indicate to children that there is an opportunity to learn something *new* and *relevant* (Csibra & Gergely, 2006). I would like to integrate this perspective into the anticipatory framework as a special case of a more general process in which children are learning about different types of possible interactions with people in different types of situations (not just pedagogical ones).

One of the most significant theoretical consequences of the anticipatory framework is that imitation itself involves learning and development. Children must come to know that other people can be a reliable source of information. Exploring this assumption has two parts: reliability in the current situation and reliability in the longer

term (i.e., attachment). Regarding the former, there has been a flurry of recent work looking at how the reliability of a model can influence whether children will accept a label that they are given for a novel object (Harris, 2007; Corriveau, et. al., 2006; Koenig & Harris, 2005a;b); however, there is very little work that has extended this perspective to consider its relevance for imitation (Zmyj et. al., 2010). Therefore, I plan to empirically explore the role of trust in imitation situations by manipulating the reliability and the success of the model providing the demonstration. I hypothesize that children will preferentially imitate a previously reliable or successful model over one that is neither of these, but that they will prefer to copy the behavior of a currently successful model even if they were unreliable in the past (i.e. general reliability will be less relevant than success in a particular situation). Further, I would like to explore what children will imitate when they are given *partially* conflicting demonstrations (either by the same person or by two different people) for how to manipulate a novel object. I hypothesize that they will imitate what is common across the partially conflicting demonstrations and ignore those transformations that were unique to only one of them because multiple (partially conflicting) demonstrations will help children discover what steps are necessary.

In the longer-term sense of reliability, children's attachment styles should have implications (at an individual differences level) for their imitation activity in different types of situations (Corriveau et. al., 2009). Children make use of others in ways that are adaptive to their own purposes and motivations. In turn, these adaptive strategies are going to be related to children's broader cognitive abilities. In novel problem-solving situations (i.e., with a clear purpose and instrumental motivation to reach the outcome) I

anticipate that securely attached children will be more open to an imitation strategy for very difficult problems (high uncertainty) or very easy problems (low uncertainty) but less willing for problems of medium difficulty. In contrast, I expect insecure-avoidant children to be less willing to imitate an adult model except when problems are very difficult and that insecure-resistant children will always imitate regardless of problem difficulty.

Another realm of potential exploration concerns 3rd-party (or child-initiated) imitation. While early dyadic imitation involves significant social structuring by the adult, the need for this type of scaffolding gives way to more child-initiated forms of imitation later on. That is, as children develop the cognitive ability to deploy imitation as a strategy to suit their own interests (cognitive or social), research is needed that shifts from adult-initiated pedagogical interactions to child-initiated 3rd-party situations. It could be the case that the emergence of "self-awareness" and the subsequent emergence of certain perspective taking abilities are an essential aspect of what would be required for this type of 3rd-party imitation; however, very little empirical work seems to have been done on this type of question (Herold & Akhtar, 2008).

Finally, given the wealth experimental research trying to determine the precise nature of the relationship between Autism Spectrum Disorders (ASD) and imitation activity, new insights regarding the latter should have relevant implications for the former. In particular, ASD has been argued to involve a deficit in social and communicative motivations (Nielsen & Hudry, 2010). Accordingly, this should make the exploration of 3rd-party imitation particularly relevant given the absence of the social and communicative aspects normally found in dyadic imitation interactions.

Conclusion

The study of social cognition is overwhelmingly dominated by the (mostly taken-for-granted) assumption that FP provides the proper framework for understanding how people navigate their social environments. Consequently, mentalism permeates the study of social-cognitive development in general and the study of imitation in particular. The open questions typically concern what mental attributions children are capable of at what ages. The framing of the issue in this way tends to preclude non-mentalistic alternative frameworks for how to understand social-cognitive development in general. Consequently, experimental research typically does not adequately differentiate between mentalistic and non-mentalistic alternative interpretations. Further, when adequate non-mentalistic alternatives are tested, they often demonstrate that mentalistic interpretations are no longer supported by the data. The current research project has not only attempted to provide empirical evidence for the value of a non-mentalistic interpretation of children's helping and imitation activity but to suggest that the robust cognitive ontology of interactivism is an appropriate alternative framework for how to study social-cognitive development as a whole.

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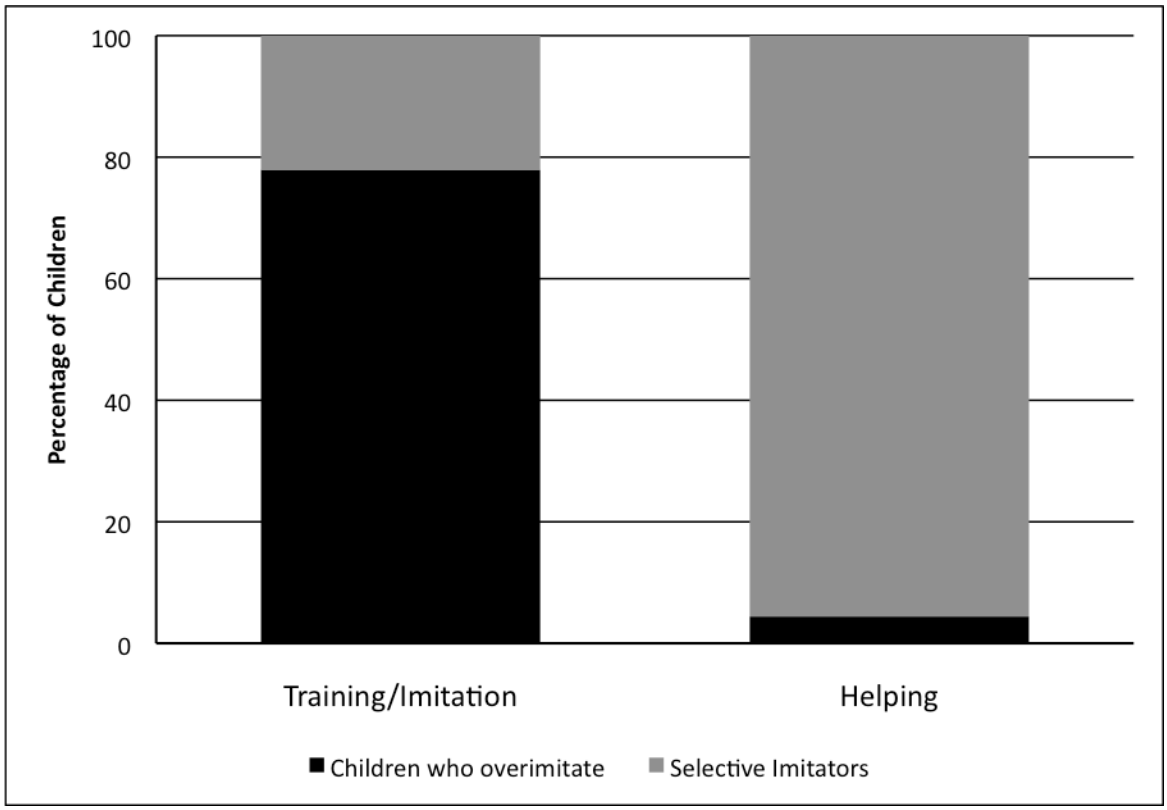

Figure 1. Percentage of children who over-imitated in the training phase versus the helping phase of the experiment ($\chi^2 = 72.43$, $p < .001$).

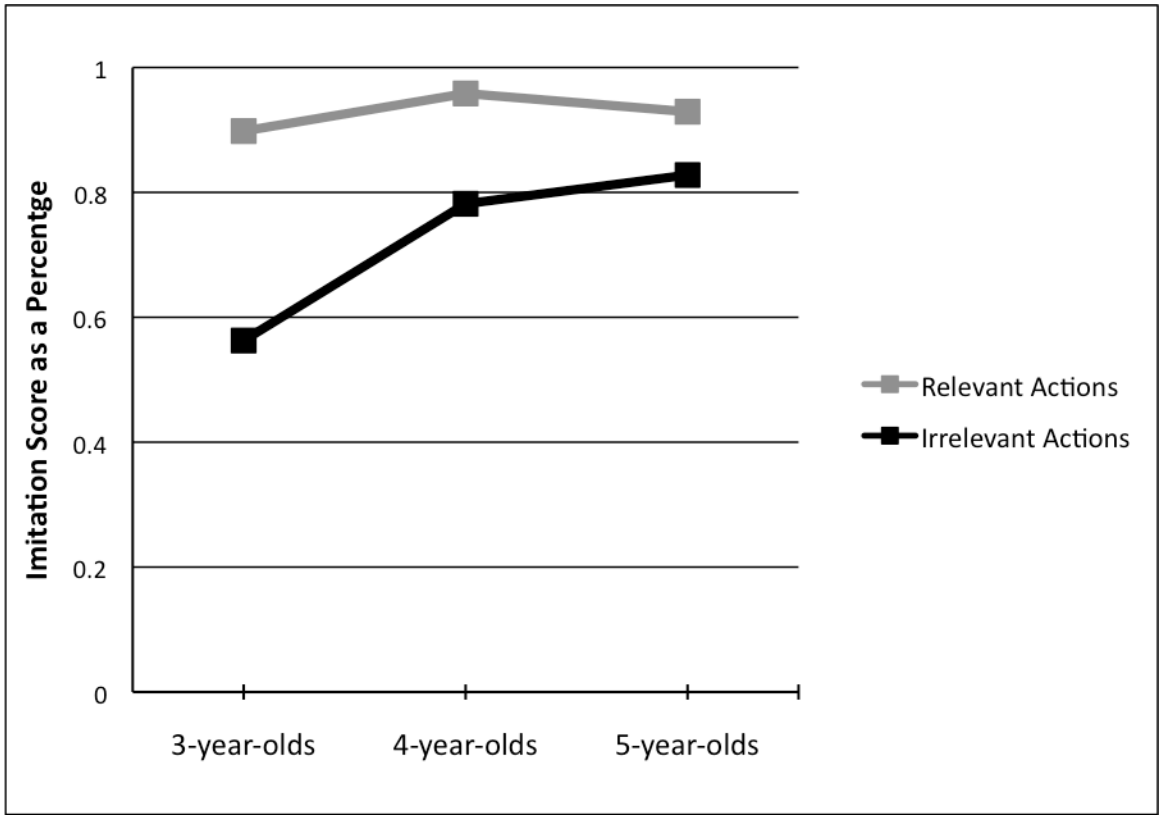

Figure 2. Imitation scores for relevant and irrelevant target actions for 3-,4-, and 5-year-olds. Children's imitation score is given in a percentage for clarity of comparison because there were only two relevant actions possible while there were three irrelevant actions possible. Post hoc analyses indicated that for irrelevant actions only, 4- and 5-year-old children differed significantly from 3-year-olds ($p < .001$ for both) but not from each other ($p = .500$).

Tabel 1

Average number of times that children produced each of the five distinct target actions at any point throughout the imitation phase.

	M	SD
Step 1	3.29	1.37
Step 2	2.82	1.67
Step 3	4.04	1.27
Step 4	2.49	1.73
Step 5	4.13	1.64

Note. Step 5 differed significantly from steps l, 2 and 4 ($p < .001$) but not step 3 ($p = .628$).

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Curriculum Vitae

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EDUCATION

Expected (January, 2012)	Ph.D. in Developmental Psychology (Cognitive Science minor) Lehigh University, Bethlehem, Pennsylvania Dissertation: "Imitation Situations: Learning to Use Others as a Resource for Further Activity"
May, 2007	M.S. in Cognitive Psychology Lehigh University, Bethlehem, Pennsylvania Thesis: "Degree of Productivity Differentially Affects Priming of Suffixed Words in English"
June, 2003	B.S. in Cognitive Science (Psychology minor) Simon Fraser University, Vancouver, Canada

RESEARCH INTERESTS

- Most broadly I am interested in the nature, learning, and development of knowledge within the specific domains of socio-cognitive and cognitive development in infancy and early childhood. Areas of interest include: imitation, mindreading/mentalism, infant research methodology, the nativist-empiricist debate and the emergence of new knowledge.

JOURNAL PUBLICATIONS

Allen, J. W. P. & Bickhard, M. H. (this paper has been selected by the Jean Piaget Society to appear as a target article for commentary and response in its official journal of *Cognitive Development* – July 2012). Stepping off the pendulum: Why only an action-based approach can transcend the nativist-empiricist debate.

Bickhard, M. H. & Allen, J. W. P. (response to commentary from target article).

Allen, J. W. P. & Bickhard, M. H. (2011a). Emergent constructivism. *Child Development Perspectives, 5,* 164-165.

Allen, J. W. P. & Bickhard, M. H. (2011b). Normativity: A crucial kind of emergence. *Human Development, 54,* 106-112.

Allen, J. W. P. & Bickhard, M. H. (2011c). You can't get there from here: Foundationalism and Development. *Behavioral and Brain Sciences, 34,* 124-125.

JOURNAL PUBLICATIONS IN PREPERATION

Bickhard, M. H. & Allen, J. W. P. (in prep). The Age 4 transition: Internal reflection as a domain general enabling constraint on explicit reasoning.

Allen, J. W. P. & Bickhard, M. H. (in prep). How to help: An alternative (non-mentalistic) perspective on Buttelmann's active helping paradigm.

Allen, J. W. P. & Bickhard, M. H. (in prep). Imitation situations: Learning to use others as a resource for further activity.

Allen, J. W. P. & Bickhard, M. H. (in prep). Over-interpreting over-imitation: Imitation learning always involves a broader type of situation with both cognitive and motivational aspects.

CONFERENCE PAPER PRESENTATIONS

Frazier, P. A. & Allen, J. W. P. (2011, July). *In the pursuit of goals: An interactivist approach.* Paper talk presented at the 6th Biannual Interactivist Summer Institute, Syros, Greece.

Allen, J. W. P. (2010, June). *The relevance of Piagetian theory for current imitation research*. Paper talk presented at the 40th Annual Jean Piaget Society Conference, St. Louis, Missouri.

Allen, J. W. P. & Bickhard, M. H. (2010, June). *An emergent-constructivist perspective on learning and development*. Paper talk presented at the 40th Annual Jean Piaget Society Conference, St. Louis, Missouri.

Allen, J. W. P. (2009, June). *Conceptual issues concerning foundationalism.* Paper talk presented at the 5th Biannual Interactivist Summer Institute, Vancouver, Canada.

Allen, J. W. P. (2009, June). *On the possibility and nature of Piaget's relevance for contemporary developmental psychology.* Paper talk presented at the 39th Annual Jean Piaget Society Conference, Park City, Utah.

Allen, J. W. P. (2009, March). *Stepping off the pendulum: How to transcend the nativist-empiricist debate.* Paper talk presented at the 80th Annual Conference of the Eastern Psychological Association, Pittsburg, PA, USA.

Allen, J. W. P. (2008, June). *Foundational issues: Why should we care?* Paper talk presented at the 38th Annual Jean Piaget Society Conference, Quebec City, Canada.

Allen, J. W. P. (2007, June). *Why only a thoroughly action based approach can fully transcend the Navtivist Empiricist epicycles and ground mind in the natural world.* Paper talk presented at the 37th Annual Jean Piaget Society Conference, Amsterdam, Holland.

Allen, J. W. P. (2007, May). *Why only a thoroughly action based approach can fully transcend the Nativist Empiricist epicycles and ground mind in the natural world.* Paper talk presented at the 4th Biannual Interactivist Summer Institute, Paris, France.

CONFERENCE POSTER PRESENTATIONS

Allen, J. W. P. & Bickhard, M. H. (2011, January). *An alternative perspective for understanding imitation activity.* Poster accepted for presentation at the 2nd Annual Budapest CEU Conference on Cognitive Development, Budapest, Hungary.

Allen, J. W. P. (2009, August/Cancelled). *Transcending the nativist-empiricist debate: The need to consider foundational issues.* Poster accepted for presentation at the 117th Annual Conference of the American Psychological Association, Toronto, Ontario, Canada.

Grant, S., Allen, J. W. P., & Sokol, B. (2004, June). *The relation between children's understanding of seriation and interpretation.* Poster presented at the 34th Annual Jean Piaget Society Conference, Toronto, Canada.

RESEARCH EXPERIENCE

2010-present **Graduate Researcher**
Department of Psychology, Lehigh University
This has involved constructing a participant database, designing and setting up lab facilities, recruiting and mentoring three research assistants.

2004-2007 **Graduate Research Assistant** to Dr. Laura Gonnerman, Department of Psychology, Lehigh University
Investigating the relationship between semantics, phonology and morphology which included: (a) looking at the graded behavior of subject's reaction time's in response to morphological priming phenomena; (b) attempting to model such phenomena using the

computational principles of connectionist networks; (c) exploring the implications of these principle for adult processing; (d) investigating the developmental trajectory of morphology acquisition in children.
Tasks included: research design, creation and preparation of materials, constructing research equipment (baby box), collecting data, supervising undergraduate research assistants, conducting literature searches.

September, 2003-June, 2004 **Undergraduate Research Assistant** to Dr Bryan Sokol, Department of Psychology, Simon Fraser University
-Research on moral development.

January, 2003-June, 2004 **Undergraduate Research Assistant** to Dr. John McDonald, Department of Psychology, Simon Fraser University
-Used EEG methods to study attention.

TEACHING INTERESTS

- I am able to teach introductory and upper-level undergraduate courses in several areas (development, cognitive science, cognition, statistics and research methods) as well as advanced graduate seminars in my area of specialization that include: Developmental Cognitive Science, Controversies in the Developmental Sciences, Theories of Cognitive Development, Infant Cognitive Development, and Infant Social Cognitive Development.

TEACHING EXPERIENCE

Summer, 2010 **Instructor**, Lehigh University – Course: Seminar in Infant Development
-Overall, the instructor's teaching was effective: 4.8/5.0
-Overall, the quality of the course was good: 4.8/5.0

Summer, 2009 **Instructor**, Lehigh University – Course: Child Development
-Overall, the instructor's teaching was effective: 5.0/5.0
-Overall, the quality of the course was good: 4.8/5.0

Summer, 2008 **Instructor**, Lehigh University – Course: Cognitive Psychology
-Overall, the instructor's teaching was effective: 4.0/5.0
-Overall, the quality of the course was good: 4.1/5.0

Summer, 2007 **Instructor**, Lehigh University – Course: Statistical Analysis of Behavioral Data
-Overall, the instructor's teaching was effective: 4.5/5.0
-Overall, the quality of the course was good: 4.5/5.0

Fall, 2004	**Guest Lecture,** Lehigh University, Introduction to Child Development: *A dynamical systems approach to cognition*
Spring, 2004	**Guest Lecture**, Simon Fraser University, Development of Children's Thinking: *A dynamical systems approach to developmental psychology*
Fall, 2010	**Instructor Training**, Lehigh University Multicultural and diversity workshop
Fall, 2009 Spring, 2008	**Instructor Training**, Lehigh University Two 6-Week Courses: Level 1 & 2 of the Teacher Development Series
Fall, 2009	**Teaching Assistant**, Lehigh University Course: Adulthood and aging
Spring, 2009	**Teaching Assistant**, Lehigh University Course: Introduction to Developmental Psychology
Spring, 2008	**Teaching Assistant**, Lehigh University Course: Mind and Brain
Fall, 2007	**Teaching Assistant**, Lehigh University Course: Introduction to Psychology
Spring, 2007 Fall, 2006	**Teaching Assistant**, Lehigh University Course: Research Methods in Psychology
Spring, 2006 Fall, 2005	**Laboratory Instructor**, Lehigh University Course: Statistical Analysis of Behavioral Data
Fall, 2004	**Laboratory Instructor**, Lehigh University Course: Statistical Analysis of Behavioral Data

OTHER EXPERTISE

Fall, 2010 Spring, 2009 Spring, 2005	**Technical Graduate Assistant**, Lehigh University • Responsible for managing the Psychology Department participant pool for department research • Responsible for creating and updating departmental web pages using Dreamweaver • Provided technical support for faculty and student computer labs

PROFESSIONAL SERVICE

2009, 2011	**Conference Reviewer** for the Eastern Psychological Association
2009	**Conference Reviewer** for the Cognitive Science Society
2007	**Conference Reviewer** for the European Cognitive Science Society
2007-present	**Graduate Student Member of the Cognitive Science Supervisory Committee** for the undergraduate program at Lehigh
2008-present	**Member of the Organizing Committee** for the Interactivist Summer Institute (ISI) Bi-annual Conference, Syros, Greece
2009	**Paper Session Chair** at the 80th Annual Conference of the Eastern Psychological Association, Pittsburg, PA, USA
2006	**Conference Coordinator Graduate Assistant** for the Society for Experimental Social Psychology (SESP) Annual Conference, Philadelphia, PA
2006	**Judge** for the Behavioral Sciences Section of the Lehigh Valley Science & Engineering Fair
2005-2007	**Regional Judge** for Odyssey of the Mind: Creative Problem Solving Competition
2005-2006	**Graduate Student Representative** for the Psychology Department Graduate Committee
2004-2005	**Journal Reviewer** for the Canadian Undergraduate Journal of Cognitive Science
2003	**Assistant Editor** for the Canadian Undergraduate Journal of Cognitive Science

HONORS AND AWARDS

2006	Lehigh University Summer Research Fellowship

1998 Ford Auto Skills Challenge Scholarship

1993 Ranatra Fusca Creativity Award (Odyssey of the Mind)

PROFESSIONAL MEMBERSHIPS

Society for Research in Child Development
Jean Piaget Society
Interactivist Summer Institute
Div 24 of APA: Society for Philosophical and Theoretical Psychology
Cognitive Science Society
Society for Philosophical Psychology
Eastern Psychological Association